POWER

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Make It Easy

IT is natural for one not exactly to shirk, but not to do as promptly and regularly and thoroughly anything that is difficult and disagreeable as something that is easy.

And this is all the more natural and true if he feels that the difficulties and discomforts are easily avoidable.

You can get more and better results out of your men by making their task as simple, as easily understood and as agreeable to perform as its nature will permit.

Light and ventilation may cost something, but you will get and keep better help in clean, comfortable surroundings with the conveniences that encourage a man to keep himself presentable than you will with a nail on the wall for a wardrobe and a pail of dirty water for a lavatory.

Rents are high and space is valuable, but before you crowd machinery so that one can hardly get around it, think of the man who has to take it apart once in so often and what may happen if that "so often" is not often enough.

Before you stick that valve in an unreachable or awkward position, think of the men who will have to open and close and pack it.

Fixed lights upon gages, thermometers, oil feeds, etc., that should be frequently observed, handy outlets for extension lights, safe platforms for inaccessible parts requiring regular attention, fixed steps for mounting to apparatus out of easy reach — all make the day's work easier and more likely to be well and regularly done.

Such things cost a little money. They cost more in the thought and observation of one who can see their need and service. Their return upon the investment is sure, if irreducible to an exact expression in dollars and cents.

F. R. Low

Mixed-pressure Turbine an Important Link in Improving Ice Plant

INSTALLING a steam-electric drive makes possible the addition of two seventy-five ton ice machine in place of one thirty-ton steam-driven unit, and increases economy of manufacture.

By F. A. WESTBROOK
Consulting Engineer

ON ACCOUNT of being in a rapidly growing residential section of the city, the Desbrook Ice Company, Brooklyn, N. Y., found it necessary to make plans for present and future additions to the capacity of its plant. This was not a simple matter because most of its power equipment was designed for steam drive and there was no space available in the engine room for additional machines. The company operates its own steam plant instead of buying central-station power because it is also in the coal business and has a large amount of screenings available, which cannot be disposed of to its regular customers and consequently furnishes cheap fuel. The problem, therefore, resolved itself into replacing some of the old units with new ones of the more efficient electric-driven type.

The former maximum production of ice was 210 tons per day of twenty-four hours. This was accomplished by means of one 90-ton, one 65-ton and one 30-ton ammonia compressor, total capacity 185 tons, driven by separate noncondensing Corliss engines. This machinery together with the necessary boiler capacity occupied all the space available in the power house.

An analysis of the seasonal fluctuation of the business showed that two new 60-ton electric compressors would carry the production during the six slack winter months for a long time to come, and that by retaining the existing 65-ton machine and the 90-ton machines, the combined capacity of 275 tons would be sufficient for the maximum demands of the six warm months of the year. This meant that the 30-ton Corliss engine-driven unit could be dispensed with and the problem was to substitute two 60-ton machines in its place. The plans ultimately were changed to provide for two new 75-ton units instead of those of 60-ton. One of these was

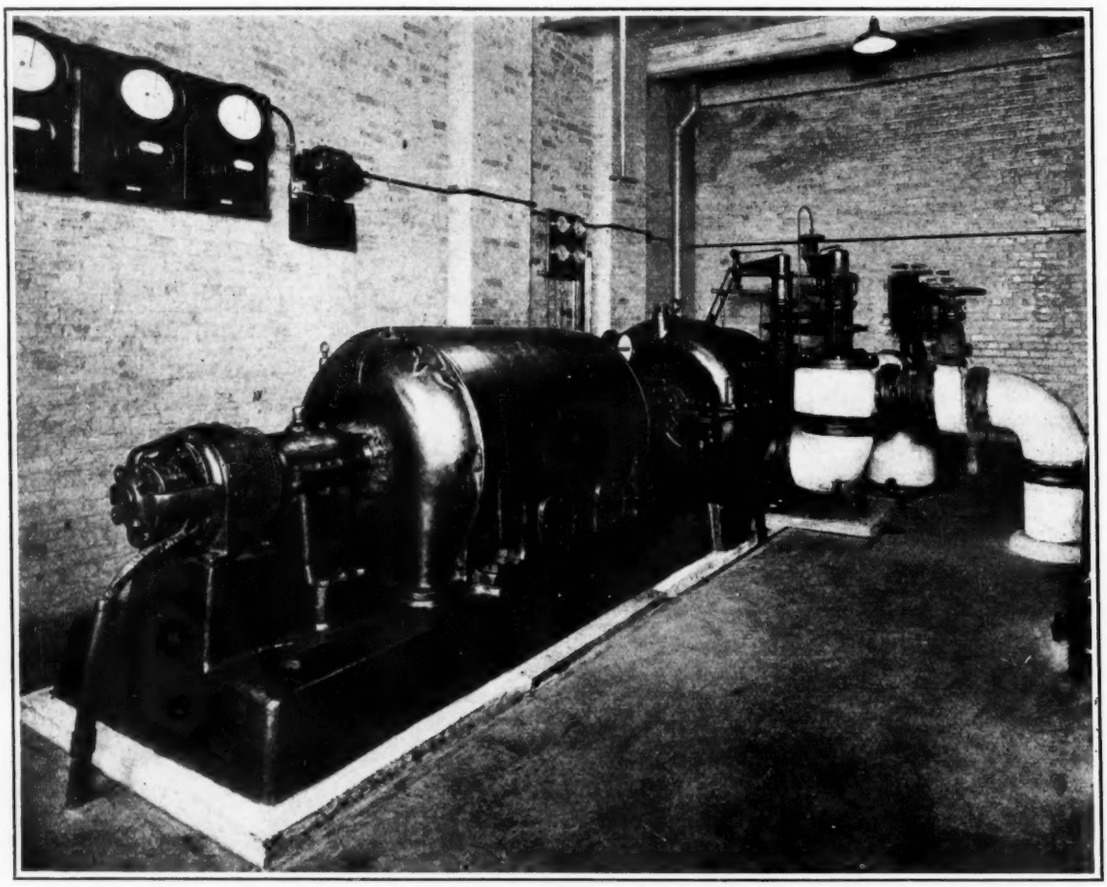


Fig. 1—Mixed-pressure Terry turbine improves plant economy by utilizing engine exhaust

installed and found to make the desired increase of production possible at a pronounced saving.

It was found after making steam-consumption tests that by installing a 500-kw., 125-lb. and 16-lb. abs. mixed-pressure alternating-current turbo-generator and using the exhaust steam from the two Corliss engines retained, plus a small amount of high-pressure steam when necessary, it would be possible to install the two new 60-ton compressors, drive them by means of synchronous motors and also remove one boiler. The two motor-driven compressors could fit into the space occupied by the one 30-ton Corliss-engine-driven compressor and the turbo-generator outfit and its condenser could take the space of the superfluous boiler.

With this arrangement the electrically operated compressors being of sufficient capacity for cold-weather production, would be run the year around and the old, less-efficient machines would be brought into use only during the warm weather. Of course in winter when the noncondensing Corliss engines are shut down, the condensing turbine would run on high-pressure steam. In this way production could be increased about 18 per cent and the cost per ton of ice decreased about 65 per cent. The change, involving the dismantling of existing machinery, could be made during the winter when only a part of the machinery was needed.

Tables I and II show the schedule of ice production and cost which can be secured, and at the end of these tables are summaries showing the old and new units of production.

The estimated investment required based on two new 60-ton units would total $65,700. To this should be added 20 per cent, or $13,140 for contingencies and engineering, making a grand total of $78,840.

The annual savings realized from the new 60-ton equipment in coal and labor as shown in Tables I and II as hereinafter explained, are:

Coal	$22,500
Labor	4,500
Total	$27,000

Assuming fixed charges as 15 per cent of the investment of $78,840, that is, 6 per cent interest, 6 per cent depreciation and 3 per cent taxes and insurance, we have $11,826. Therefore,

Gross saving is	$27,000 year
Fixed charges are	11,826 year
The net saving is	$15,174 year

or 19 per cent on the capital investment.

The cost of coal under the old arrangement was, as shown in Table II, $0.85 per ton of ice and with the proposed equipment $0.40 per ton of ice. Under a normal yearly production of 50,000 tons the total cost would be $42,500 with the old equipment and $20,000 with the new, thus giving a saving of $22,500.

With regard to labor the same number of men can handle the new equipment as the old but since the new production is 50,000 tons per year instead of 42,000 the cost per ton is reduced from $0.67 to $0.58 (Table II), resulting in a total saving of

$$50{,}000 \times 0.67 - 50{,}000 \times 0.58 = \$4{,}500$$

The cost of water for ice does not change, and the cost of power for pumping the cooling water for the turbine condenser is included in the fuel consumption. Furthermore, the maintenance of the turbo-generator and electrically driven ammonia compressors is less than that of the steam compressors, and the boiler maintenance will also be decreased on account of the elimination of one boiler unit. Thus the maintenance of the plant as a whole with its increased capacity, is at least no greater than formerly.

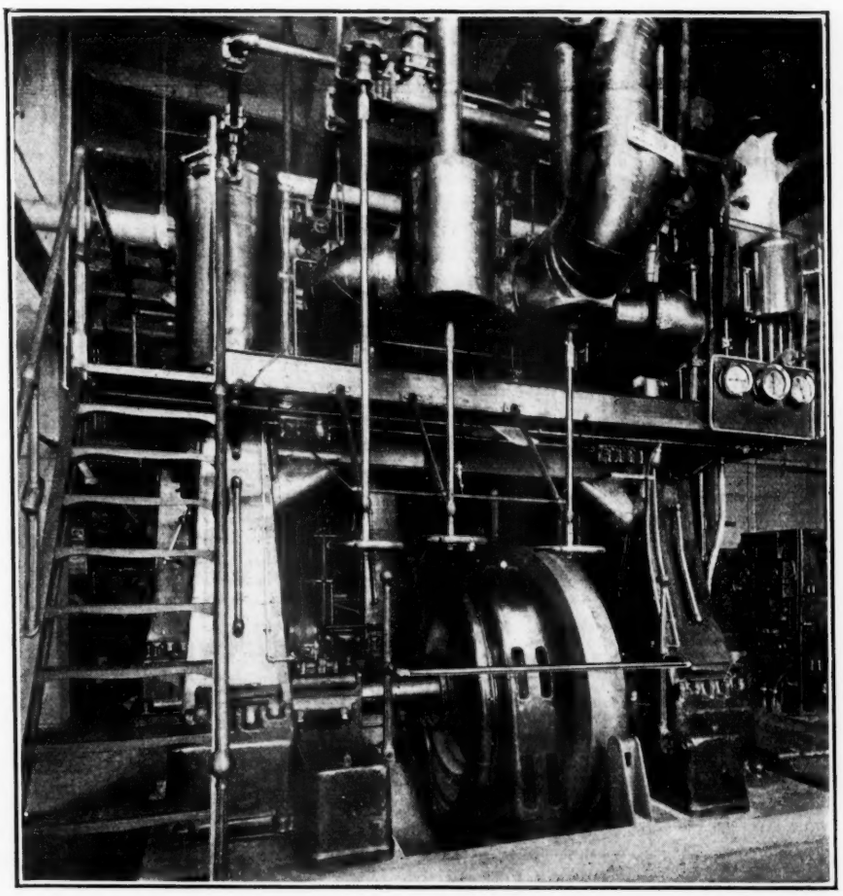


Fig. 2—Synchronous motor of 200 hp., 174 r.p.m., drives York ice machine with turbine power

One 75-Ton Ice Machine Installed

Up to the present only one of the new electric compressors has been installed because the demand for ice does not yet warrant both machines. Instead of using a 60-ton ice machine, one of 75-ton capacity was installed. The turbo-generator, of course, is of sufficient size to carry another similar ice machine when the demand warrants.

That the turbo-generator set is highly efficient from the maintenance viewpoint, is demonstrated by the fact that last summer it ran continuously for six months night and day without being stopped once.

In order to secure the desired results, it was necessary to install a highly efficient condenser for the tur-

bine capable of producing 20-in. vacuum. This, in turn, depended on an adequate supply of cold condensing water the year round, and how it was obtained is an interesting detail of the installation.

There was formerly a driven well about 60 ft. deep which supplied 200 gal. of cooling water per minute for the ammonia condenser and steam condensers for distilled-water ice. A steam pump was used for this water. With the new turbine it was necessary to have 500 gal. of cooling water per minute in addition. To secure this a pipe of somewhat smaller diameter than the original one for the well, and with a perforated wall, was driven some distance down below the existing 60-ft. depth. By means of a centrifugal pump the sand was pumped out and gravel put down in its place. This was continued until no more sand came up, and by that time the flow of the well increased to 1,200 gal. per min. at 53 deg. F., which was sustained without interruption for a week.

Existing motors in the plant were all of the direct-current type, and the delivery wagons were also electric and required direct current for charging, so that a motor-generator set was installed to convert some of the three-phase alternating current of the turbo-generator to direct current because it was found cheaper to do this than to replace the old motors and delivery wagons.

A further feature of the installation from the viewpoint of efficiency was the control for the synchronous motor driving the new compressor. This was so arranged that one man on the engine-room floor can start it by push-button automatic control. This was particularly desirable because the plant runs at night and because the only available location for the switchboard is near the turbo-generator set on a mezzanine platform.

Operating data covering a typical two-week period of hot weather show actual coal consumption and ice produced with the partly rearranged plant containing one new 75-ton unit to be 224 tons of coal and 3,150 tons of ice. This equals 14 tons of ice per ton of coal. Coal cost as fired is $5.60 per ton, and hence the cost of fuel per ton of ice is 40 cents. With $6 coal it would be 43 cents.

In other words, with only a part of the additional production capacity in service, results of this one week approximately equal the estimated fuel rate based on yearly operation as originally planned. The saving in labor has not been reduced the full amount because the same number of men are required as formerly, but the full increase in production has not been realized. The actual expenditure for the installation to date is given in Table III.

To bring the plant up to the full capacity as originally estimated, it will only be necessary to spend the item of $16,900 for an additional ice-making machine, as all other details of the installation have been made with this ultimately in view. As a matter of fact, this provides for two new 75-ton ice machines instead of two 60-ton machines, which fully justifies the slight increase over the estimated cost.

This work, as planned and eventually carried out by William Brown & Company, Engineers, of 30 Church St., New York City, gives an idea of the great improvements in economy that can be secured by small-sized turbo-generator units and also furnishes an excellent illustration of how the efficiency of an industrial plant which has been operating at a profit can, nevertheless, be materially improved.

TABLE I—PAST ICE PRODUCTION SCHEDULE WITH FUTURE BASED ON TWO NEW 60-TON MACHINES

Periods— Month	Electric Compressors Jan.	Feb.	Mar.	Apr.	Electric and Steam Compressors May	June	July	Aug.	Sept.	Oct.	Elec. Compr. Nov.	Dec.
Present ice prod. tons (1921)	855	870	1,686	2,395	3,551	5,698	6,423	4,600	6,152	5,189	1,942	1,140
Ice production with new equipment	1,000	1,000	2,500	3,000	5,600	6,300	6,500	6,500	6,500	5,500	3,600	1,800
Days operation	17	17	21	25	31	30	31	31	30	30	30	31
Tons ice per day	60	60	120	120	185	210	210	210	210	185	120	60
Boiler steam to auxiliaries, lb. per hour	1,000	1,000	1,200	1,200	1,400	1,800	1,800	1,800	1,800	1,400	1,200	1,000
Boiler steam to turbine, lb. per hour	2,700	2,700	5,500	5,500	4,500	1,900	2,300	2,300	2,300	4,300	5,500	2,700
Total boiler steam, lb. per hour	3,700	3,700	6,700	6,700	10,500	11,200	11,700	11,700	11,700	9,300	6,700	3,700
Steam available for low pressure element, lb. per hour	1,000	1,000	1,200	1,200	5,000	9,300	9,400	9,400	9,400	5,000	1,200	1,000
Power equivalent of low pressure steam, kw	22	22	27	27	110	225	230	230	230	120	27	27
Tons of coal per month, future	75	75	169	200	390	400	436	436	420	335	240	137
Tons of coal per month, present (1921)	248	231	353	490	550	678	744	744	720	650	373	277
Tons of ice to ton of coal, future	13.3	13.3	12.7	15.0	16.9	15.8	14.9	14.9	15.5	15.0	15.0	13.1
Tons of ice to ton of coal, present (1921)	3.45	3.77	4.8	4.9	6.45	8.4	8.6	8.6	8.55	8.0	5.21	4.12

1. Total ice production—tons per year = 49,800 future.
2. Total coal consumption tons per year = 3,313 future.
3. Total ice production—tons 1921 = 42,300.
4. Total coal consumption tons 1921 = 6,058.
5. Average ratio tons ice to tons coal future = 14.62.
6. Average ratio tons ice to tons coal, present = 7.

TABLE II—PAST AND FUTURE OPERATING COST BASED ON TWO NEW 60-TON ICE MACHINES

Period 1921	Electric Compressor Jan.	Feb.	Mar.	Apr.	Steam and Electric Compressors May	June	July	Aug.	Sept.	Oct.	Elec. Compressor Nov.	Dec.
Present ice prod., tons	55	870	1,686	2,395	3,551	5,698	6,423	6,400	6,152	5,189	1,942	1,140
Future ice prod., tons	1,000	1,000	2,500	3,000	5,000	6,300	6,500	6,500	6,500	5,500	3,600	1,800
Present cost of coal, dollars (at $6 per ton, 1921)	1,488	1,390	2,120	2,940	3,360	4,050	4,460	4,460	4,320	3,900	2,240	1,660
Future cost of coal, dollars (at $6 per ton)	450	450	1,014	1,200	2,340	2,400	2,616	2,616	2,520	2,010	1,440	822
Difference in cost of coal, dollars	1,116	1,018	1,265	1,620	1,390	1,555	1,910	1,910	1,965	1,350	600	400
Present cost of coal per ton of ice, dollars	1.74	1.60	1.25	1.23	0.94	0.68	0.69	0.70	0.71	0.75	1.15	1.46
Future cost of coal per ton of ice, dollars	0.45	0.45	0.41	0.40	0.42	0.38	0.40	0.40	0.38	0.37	0.40	0.46
Reduction in cost of coal per ton of ice (future), dollars	—1.29	—1.15	—0.84	—0.83	—0.52	— .33	—0.29	—0.30	—0.35	—0.27	—0.71	—1.00
Power plant labor, present, dollars	1,670	1,670	1,670	1,670	1,670	1,920	1,980	1,980	1,920	1,620	1,620	1,670
Power-plant labor, future, dollars	1,670	1,670	1,670	1,670	1,670	1,920	1,980	1,980	1,920	1,620	1,620	1,670
Tank labor, present, dollars	170	170	315	375	620	900	1,080	1,080	1,050	750	600	310
Tank labor, future, dollars	170	170	315	375	620	900	1,080	1,080	1,050	750	600	310
Average cost of coal per ton of ice (present)	$0.85											
Average cost of coal per ton of ice (future)	0.41											
Average labor per ton of ice (present)	0.67											
Average labor per ton of ice (future)	0.58											
Present ice production (tons per year)												42,300
Future ice production (tons per year)												49,800

TABLE III—ACTUAL EXPENDITURE WITH ONE NEW 75-TON COMPRESSOR

Turbine Installation	Mixed pressure Terry turbine with 500-kva. generator	$18,500.00
	Surface condensor	5,500.00
	Piping for turbine	4,000.00
	Foundation for turbine	1,500.00
	Building alterations	2,500.00
	Erection of turbine	2,000.00
	Electrically operated deepwell pump with motor, piping, etc. in place	10,500.00
Ice Plant Addition	Ammonia compressor, capacity 75 tons ice, with synchronous motor, etc.	15,000.00
	Foundation, piping and erection	1,900.00
Electrical Installation	Motor generator set, 75 kw	2,000.00
	Switchboard	3,000.00
	Conduit and cable work—Material	1,000.00
	Labor	1,500.00
		$80,900.00

Increasing Financial Efficiency by Eliminating Unnecessary Initial Expense

By H. M. VEHLING and H. S. CRAWFORD

AN ANALYSIS of the first cost of a number of power plants built during the last four years shows that the following comparative features exist when each station is put on the same installed-capacity basis: Approximately the same amount of money was spent for equipment; a material difference exists in the cost of structures; a considerable variation exists in the cost of site preparation and the rest of the items that make up the complete power plant.

As little can be said regarding reducing the cost of equipment, this article will be restricted to a consideration of how the financial efficiency of the power plant can be improved by the following means: The selection of a more suitable building site, thereby avoiding construction difficulties as much as possible; efficiency in engineering and management during the designing and construction period; simplification and compactness of design as applied to all station structures.

THE authors feel that many highly important matters have been largely overlooked in the laudable search for thermal efficiency, which is but one element of several entering into financial efficiency. Boiler-room design, as affecting financial effiiciency, was discussed in the May 19 issue. The July 21 issue contained a similar study of turbine-room design. In the present article the authors give particular attention to the selection of station sites, reducing the cost of engineering and construction, etc.

In selecting a power-plant site, comparative estimates should be made which feature all the adverse conditions that might cause excessive initial investment. Such items are as follows: Shore or river protection, excavation, dredging or piling, circulating-water canals or tunnels and their length, intake basins, substructures, foundations, coal-receiving facilities by boat or rail, cost of real estate, proximity of load center, tracks, grading, coal storage, ash disposal, etc. Knowing that each of these items may materially affect the cost of a power plant, it is by avoiding adverse conditions and minimizing construction costs as much as possible that the designer can effect a material increase in financial efficiency.

The prevailing opinion that any low-cost site, close to the load center and having a clean and adequate water supply, is necessarily desirable in a station site, is far from correct. For instance, a tract of swamp land may be purchased at a low price, but the cost of dredging, piling, docks, concrete mats, ponderous substructures, etc., puts an entirely different aspect upon such an investment. The same applies to a site with high embankments. Here the cost of excavation, extensive retaining walls, circulating-water tunnels instead of canals and other items of construction may amount to many times the difference in cost between the site under consideration and the possible higher cost of a more favorable site that does not require extensive preparation.

Certain expenses are generally inherent in the geographical location of the plant. For instance, a river site usually requires flood protection such as levees, river walls, river mats, cofferdams, dredging, watertight condenser compartments, etc. An ocean, bay or inland lake location usually requires shore protection, although in some favored localities this item of expense may not be necessary.

If adverse locations are unavoidable, the station should be erected on a site requiring minimum investment considering all factors involved. The requirements of an ideal site are as follows: Low elevation above water line, firm soil to eliminate artificial means for supporting the structures, situation adjacent to a large body of clean and cool water that is not subject to turbulence or any great variation in level and inexpensive means of coal delivery and ash disposal.

The item of comparative distance as regards proximity to load center must naturally be considered. After the load center is located as nearly as possible, the first choice of station site becomes possible at the point on the shore line closest to the load center. By extending this distance one mile and with this larger radius describing a circle about the load center, several miles of shore line are included, giving a choice of several locations. Topographical conditions are seldom such that a favorable station site could not be found along this distance. If, however, such is not the case, the radius of this imaginary circle may be further extended to include additional shore line. The additional cost of transmission lines and accompanying line losses during the life of the plant must be considered and compared with the additional first cost and fixed charges resulting from the preparation of an unfavorable site. If several large central stations are interconnected, the site limits may be further extended without incurring any considerable expense other than that of transmission-line losses.

With the station site finally selected, the next step toward reducing initial investment is to avoid construction difficulties and select only those features that make for minimum over-all expense. For instance, where the site selected has high embankments, it may be best to extend the plant partly out from the shore rather than assume the tremendous expense of excavation, circulating tunnels, etc. Where rock is encountered, it may be cheaper to locate the turbine room close to

the circulating-water supply in order to minimize the length of tunnels or canals.

Real estate near large cities is costly. It is to be noted that there is a tendency in most power plants to provide too large a property. Some station sites comprise as much as 100 acres of land, while other plants in congested districts accomplish the same result on about one-tenth this area. Substantial savings may be made by providing a small station site.

The underlying purpose of providing tracks is to facilitate a labor reduction in the handling of coal, ashes, turbine-room machinery and substation equipment. The expenditure for each of these items should be carefully analyzed and properly classified to determine its commercial feasibility. In many cases a large portion of the track system is used for ash handling only, the cost being excessive for this purpose. The possibility of economy through providing a simple yet efficient track system is usually overlooked.

Cost Reduction in Engineering, Interest and Overhead Charges

The designing period, and with it engineering expense, usually begins the moment a decision to proceed with the contemplated project is reached. The cost of engineering expense plus the interest and overhead charges ranges from 8 to 14 per cent of the total station investment. The sum of these items represents a substantial capital outlay, yet the possibility of a reduction therein is seldom considered. In carrying out the design efficiently, a material reduction in engineering charges can be effected. Important decisions should not be held up until the last moment. Snap judgment should never be allowed the place of sound reasoning, nor should personal pride, which generally forbids admitting the superiority of a better layout, ever be permitted to influence the design. If the designing engineer is competent to handle the situation, he should be given the fullest confidence, and while the preparation of comparative layouts is advisable, unnecessarily elaborate reports and drawings should not be required to convince the management that a certain project is not feasible. A few delays and changes may have the over-all effect of increasing the engineering expense by as much as 50 per cent.

In order to reduce the amount of interest paid on capital during the construction period, it is important to conclude the construction as soon as possible. A further saving in interest is obtainable by carefully timing and specifying deliveries and payments for equipment. A well-prepared "Interest" schedule, including time, quantity and delivery of construction material, is essential if the magnitude of interest charges is to be grasped readily. Foresight to prevent any interruption in the smooth and constant progress of the construction program will be well rewarded. By practicing economy in the factors that control engineering, interest and overhead charges, a reduction of from 1 to 3 per cent in station cost is possible.

Saving Due to Simplification of Design

The determining factor for the arrangement and design of power-plant structures and equipment is the straight-line-path principle in which the fuel with its heat content is given the most direct route from the coal-storage pile, through the coal-preparation plant to bunkers in the boiler room, and thence to the combustion chamber, where its heat content is liberated. This energy flow continues through the heat absorber, commonly called the boiler, and then (in the form of steam) goes straight to the turbines, where it again undergoes a change to electrical energy which in turn passes through switchhouse, transformers, substation and distribution system, eventually reaching the consumer. The importance of this principle of shortening the travel of the heat-conveying medium, with the resulting elimination of equipment and a reduction of initial investment, should not be underestimated. There are still plants going up where the path of the energy-carrying medium could be greatly simplified. The structures should be placed in accordance with the aforementioned principle with the substation on the side toward the load center. Sometimes, however, it is advantageous to turn the whole station 90 deg. from this position in order to reduce initial investment by avoiding certain construction difficulties.

Coal Handling and Preparation System

Two forms of coal storage must be provided. The first is to take care of variation and interruption of the coal supply caused by failure of transportation facilities by rail or water, strikes and other uncontrollable factors. This storage is usually provided on the ground separate from the power-plant structures. The cost of tracks, grading, excavation and real estate must therewith be considered in this connection. The other form of coal storage is to guard against the temporary breakdown of coal-conveying apparatus and is usually provided by large overhead coal bunkers either in the boiler room or coal-preparation plant or both. A comparison should be made to determine whether it is cheaper to provide small bunkers with duplicate equipment or large bunkers accompanied by heavier steelwork and expensive foundations, with single equipment.

Coal Preparation Plant

Regarding the coal preparation plant it may be said that the importance of arranging mechanical equipment in a skillful manner applies to this building as well as to any of the other power-plant structures. A system in which the coal, beginning at the receiving hopper, follows as straight a path as possible through the crushing plant and conveying system into the boiler room is to be preferred. In the case of pulverized coal new types of coal driers, suspended underneath the coal bunkers, save much space and eliminate handling apparatus, thereby simplifying the process of coal preparation. Lately, the unit system of pulverized coal is finding much favor. With further development of this apparatus, together with a new-type large-capacity centrifugal mill, the cost of the coal preparation plant may be greatly reduced.

Boiler Room and Turbine Room

The manner in which the financial efficiency can be increased by compactness of design in the boiler-room structures and placing the equipment therein has been discussed in a previous article, entitled "Increasing the Financial Efficiency of the Steam Power Plant by Simplification of Design."[1]

There is some possibility of increasing the financial efficiency by increasing the compactness of the turbine room over that existing in some of the present-day

[1] May 19 issue.

power plants. For instance, there is a marked difference in the sizes of some turbines of different manufacture for the same capacity. The increased costs of the larger building, larger turbine foundations, etc., are chargeable to the larger machines, considering of course any difference in initial cost and thermal efficiency. Furthermore, with the regenerative cycle being extensively used, the size of the condenser is reduced considerably. Shortening the condenser tubes rather than reducing the condenser diameter will permit a saving in the space required for tube withdrawal, thereby shortening or narrowing the turbine room. Installing the condenser parallel with the center line of the turbine will result in the condenser tube clearance space coinciding with that required for rotor withdrawal. The turbine foundation, however, is more complicated in this latter case. Vertical condensers which do not require any additional space for the removal of tubes, since they can then be withdrawn in the space provided for crane clearances, offer another means of effecting maximum compactness. Room for convenient operation and space for railroad tracks leading into turbine room must be provided. If these clearance-space requirements are arranged in such a manner that they will overlap, a decided saving in first cost will be effected.

As a rule the switchhouse is a ponderous structure with unnecessarily large clearances between the various pieces of electrical equipment. It is a well-known fact that some of the leading English stations have remarkably compact switchhouse structures. The cubical contents of the switchhouse can be cut down by reducing clearances to a minimum without sacrificing safety and by grouping certain low-voltage equipment with that of the high-voltage outdoor substation.

Saving in Labor During Construction

A general schedule of procedure and methods of construction and installation, for the purpose of reducing labor costs, should be laid out by the designing engineer and not be left to the construction superintendent, as he may lack a comprehensive view of the entire project, besides being too busily engaged in looking after the construction details. If, for any unforeseen reason, the original schedule cannot be adhered to, a new one should be prepared to prevent any possible confusion. Incoming construction materials should be placed in small piles surrounding the work and readily accessible. The receipt and distribution of these materials should be given careful attention. One of the leaks in the payroll is the labor wasted by the aimless placing of material arriving on the site. Much time is wasted by dumping everything on a large pile, necessitating rehandling afterward. Storage should be provided for materials affected by weather conditions. Driveways should be laid out in accordance with the general schedule plan, a loop system being preferable. Railroad tracks should be constructed permanently from the start so that machinery may be unloaded directly by the power-plant cranes.

In conclusion it may be said that the entire power-plant structure in its ultimate size should resemble as nearly as possible a perfect cube, in which all foundations, footings, floors, walkways and platforms are kept at the same elevation. Accessibility, aided by daylight and proper ventilation, is highly desirable in all building structures. It is a good practice to make provisions for future expansion and improvements in the art of steam generation. The unit system has a decided advantage in permitting plant additions to be made which incorporate the latest improvements without interfering with the operation of previous units. Good engineering practice is exhibited in designing a plant only large enough to meet the requirements for a short time, installing the latest approved equipment. The proper time to remedy faults in the thermal and especially financial efficiency of the station is during the designing period. No matter how efficient the operating organization may be, the effects of a faulty design can never be overcome without making expensive alterations. Quite often the operating engineer is blamed for low financial efficiency whereas it is not realized that he may be handicapped by an inefficient design.

A conservative layout, embodying the latest practice of proved merit, and best thermal efficiency combined with highest efficiency of capital, will prove to be the most satisfactory solution of the problem of improving power-generating practice. In reducing the cost of an item that affects the total cost of power produced by a steam power plant, it may be said, at first glance, that a small saving seems unimportant, but when an aggregation of cost reductions as outlined in this article is possible, the problem takes on an entirely different aspect. A summation of these savings shows that 25 per cent cost reduction over the average and 10 per cent over best modern practice are possible.

Owing to the mechanical construction of the plunger pump, which involves tightly packed stuffing boxes and sliding pistons, the initial breakaway torque required of a motor for starting may equal 125 to 250 per cent of normal full-load torque, depending on the tightness of the stuffing boxes, fit of the pistons, etc. Immediately upon starting, the pump delivers full capacity per stroke, with the result that full-load torque will be required throughout the remainder of the starting period if the pump is connected to a constant-pressure system. Frequently, large reciprocating pumps are equipped with a bypass, which relieves the pressure during the starting period so as to decrease the starting torque required from the driving motor.

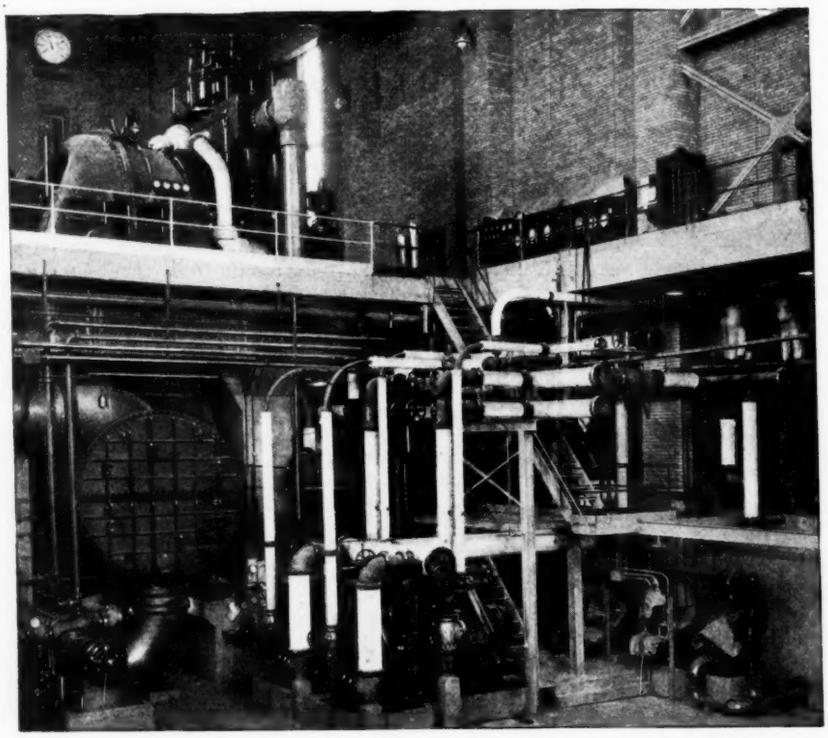
Using bare pipe as a comparison, a pipe painted with either gold or aluminum bronze at usual radiator temperatures—that is, of about 2 to 3 lb. gage and a room temperature of 70 deg.—the efficiency of the radiating surface will be decreased from 20 to 25 per cent, and if on top of the bronze a coat of white enamel is applied, the efficiency will be brought back nearly to the original efficiency of the bare pipe, or from 95 to 98 per cent. A four-column radiator painted with aluminum bronze will radiate no more heat than a three-column radiator painted white. At higher temperatures this difference in efficiencies becomes more marked, which would be expected when the physical laws governing this subject are studied.

If some engineers were as much interested in getting the maximum evaporation per pound of coal as they are in getting miles per gallon out of their flivvers, it might show in the monthly coal bills.

Superheat increases the efficiency (Rankine ratio) of some steam turbines from 1 to 3 per cent of the saturation efficiency for each 100 deg. F. increase.

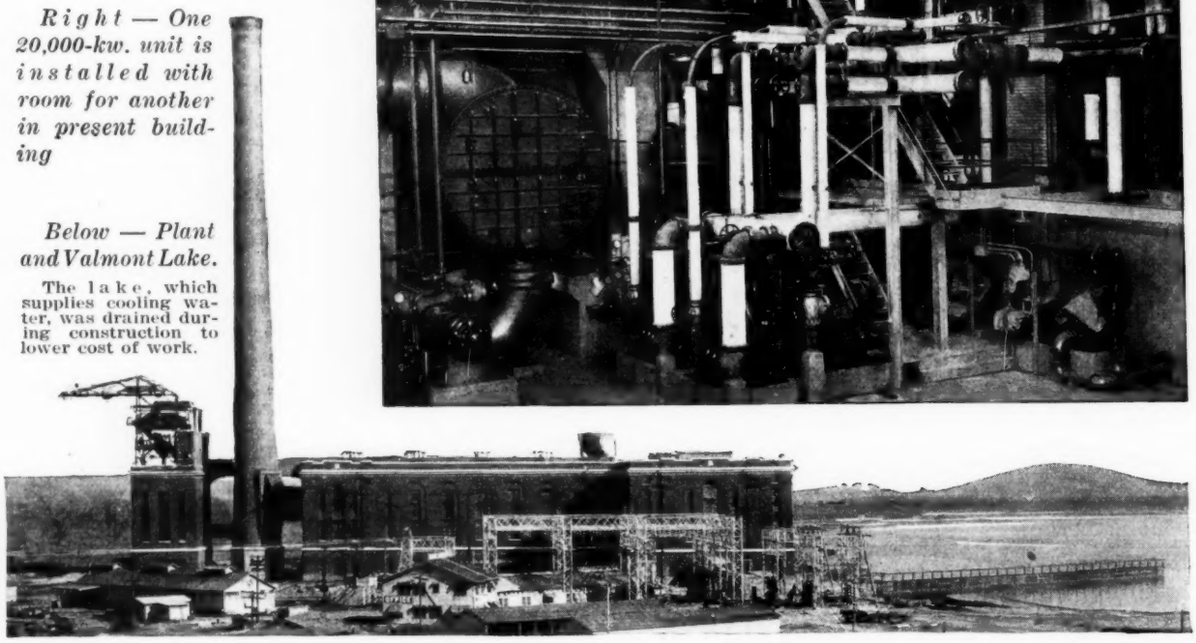
New Valmont Station, Public Service Company of Colorado

Photos by courtesy of M. W. Kellogg Co.

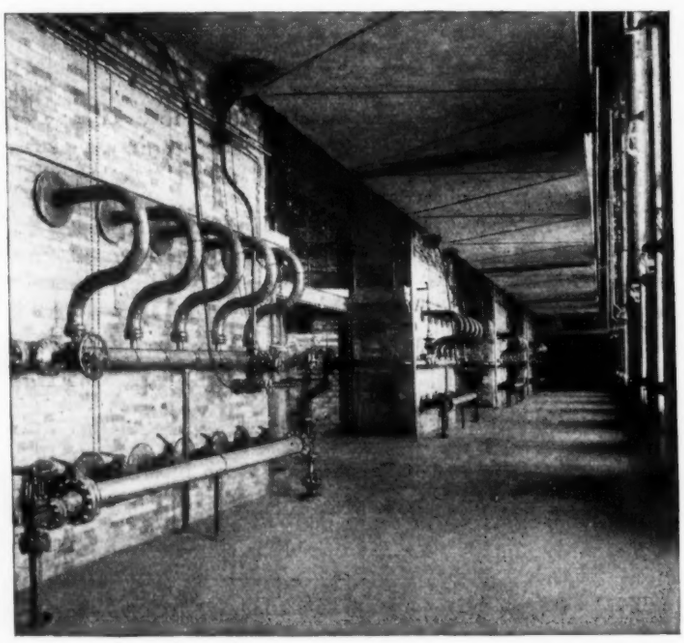


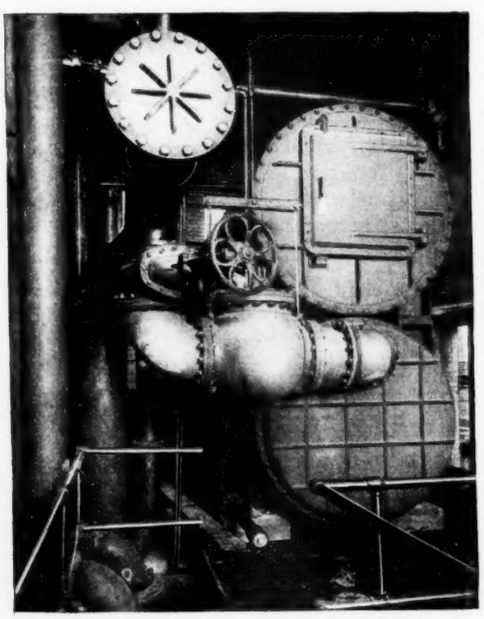
Right — One 20,000-kw. unit is installed with room for another in present building

Below — Plant and Valmont Lake. The lake, which supplies cooling water, was drained during construction to lower cost of work.

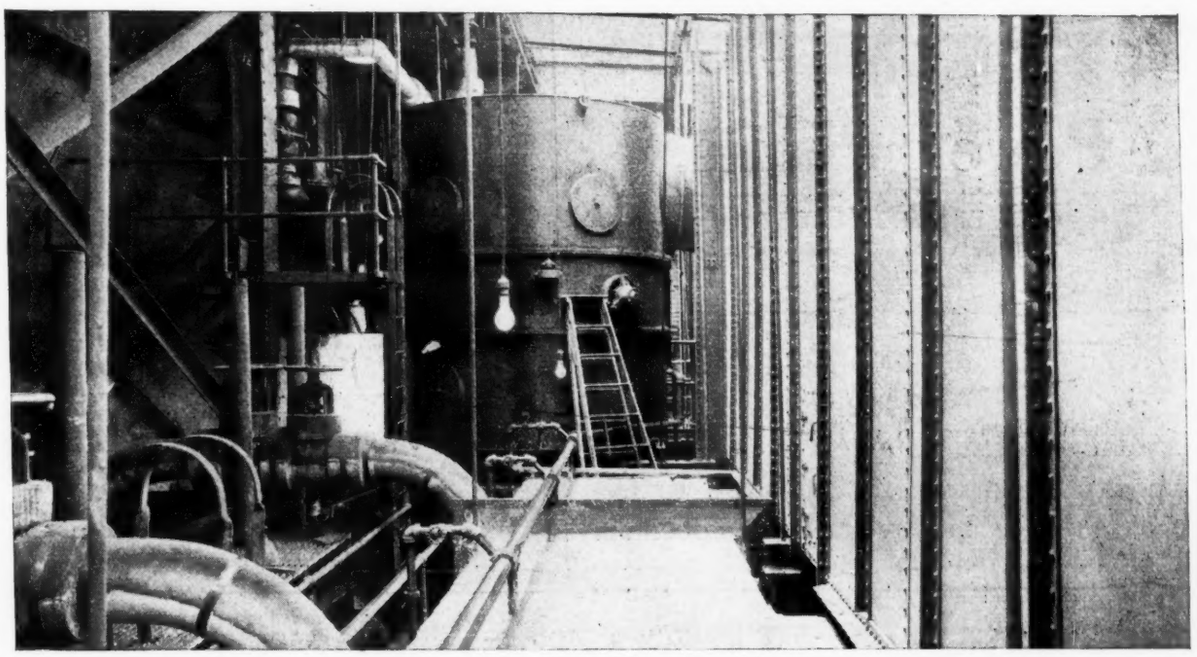


Below—Aisle back of 13,320-sq.ft. Bigelow-Hornsby boilers, fired with pulverized fuel



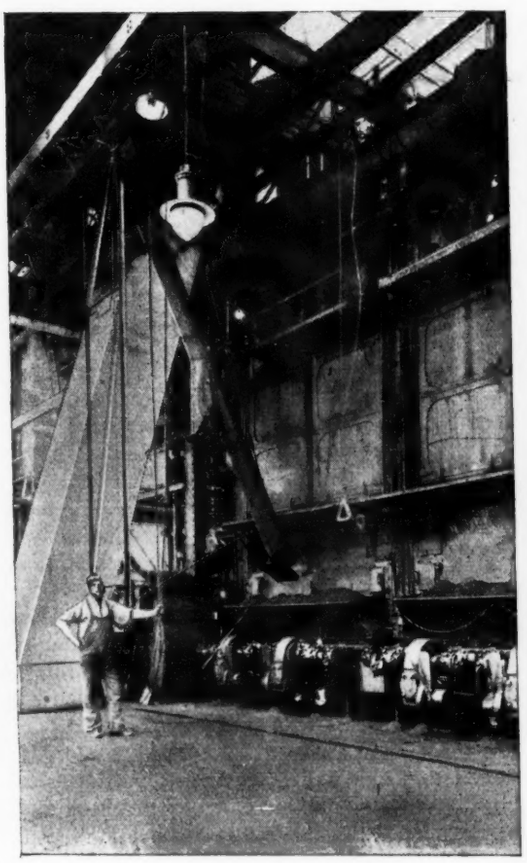


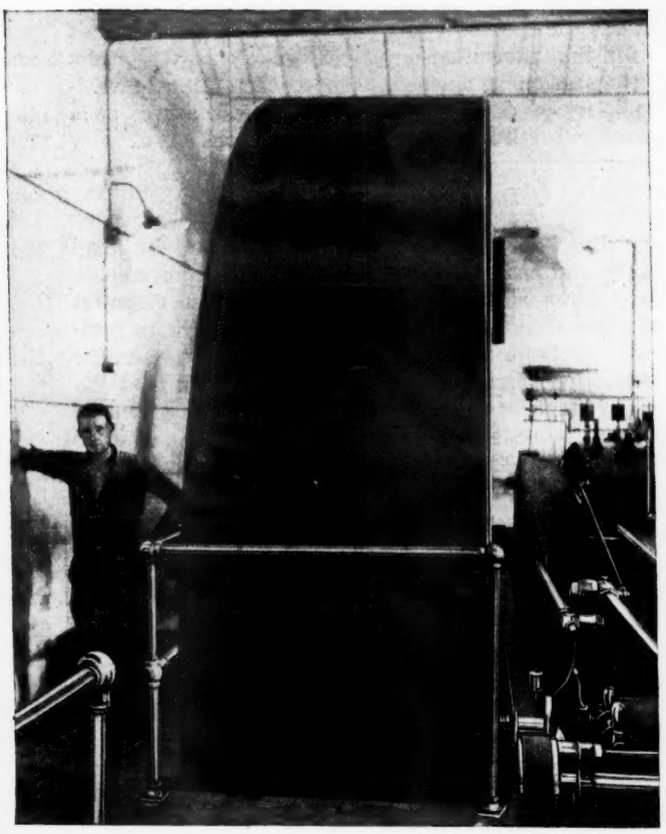
Above — Makeup water, coming from melting glacier ice, requires no softening, but this deaërator is used to prevent corrosion by dissolved gas



Above—Rotary air heater in boiler plant of Norton Company, Worcester, Mass. Preliminary tests indicate a fuel saving of from 12 to 14 per cent

Below—Another view in Norton boiler room. Large duct at left of boilers brings heated air from preheater down to stoker windboxes





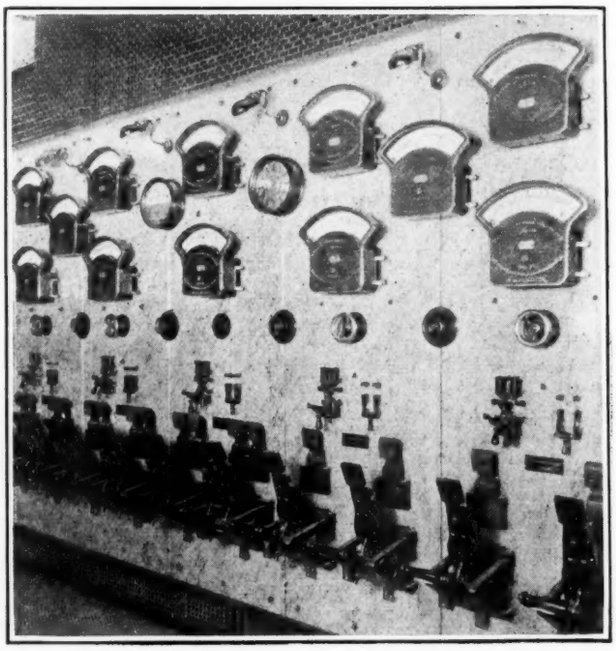
Above—Notable belt recently installed in a West Virginia lumber mill

Made of the centers of 175 steer hides, this belt is 48 in. wide, 3-ply and 117 ft. long. At a speed of 5,000 ft. per min. it will transmit 1,000 hp.

Photo by courtesy of J. E. Rhoads & Sons, Philadelphia

Switchboard Meters for Power Plants

By J. ELMER HOUSLEY
Electrical Engineer, Aluminum Company of America, Alcoa, Tennessee



Meters for Direct-Current and for Alternating-Current Plants — Determining Proper Scale Range for Instruments — Selection of Instrument Transfromers and How to Determine Proper Load for These Transformers

ELECTRIC-POWER generating unit installations in industrial plants always involve a study of various electric meters and the selection of the necessary or desirable number of meters of the proper specifications to accompany the generator installation. Proper switchboard-instrument layouts are important from the viewpoint of effective operation of each unit and for the determination of the economy of the units and the station as a whole. The consumption of various feeders or departmental circuits often serves as a barometer to production costs and efficiency of new processes.

Direct-Current Plants

The direct-current plant is often of relatively small capacity and the switchboard-instrument requirements are met by a small number of meters. The essential meters are a permanent-magnet type voltmeter to indicate the voltage and to show reversal of generator polarity. The meter should have a scale such that the normal voltage of the plant will read about 80 per cent full-scale. A reliable permanent-magnet type ammeter of the external shunt type should also be provided, at least one for each generating unit. The scale of the meter should be such that the pointer will not constantly strike the upper stop at peak loads. The more variable the load the higher the capacity of the meter should be above full load of the unit.

Where several units are installed, a voltmeter may be connected permanently to the busbars and one machine voltmeter may be used by mounting a four-point potential receptacle on each generator panel. The latter is used to enable the operator to equalize the voltage of the incoming machine with the busbars voltage. Each generator panel should be equipped with an ammeter.

While it is not necessary to provide a watt-hour meter for operating reasons, it is essential where cost data or the economy of various generating units is considered. The busbars of the plant may in some cases be profitably equipped with a recording voltmeter as an index of the performance of the station. This meter detects poor voltage regulation with its attendant lowering of speed, damage to the process material and excessive current, motors overheating, and line loss due to low voltage.

The feeder circuits of the direct-current plant are usually equipped with circuit breakers, and one ammeter per circuit may be provided to indicate the character and size of the load and the proper setting of the circuit breaker. It appears that more consideration should be given to the value of a recording wattmeter for direct-current feeder circuits. Such an instrument is invaluable in tracing and analyzing faults occurring in the equipment and on the circuits themselves. If the circuits are numerous and the expense of the individual recording meters cannot be justified, a single meter may be installed with a suitable shunt in each circuit and the meter may be attached to the circuits, in rotation at intervals, in order to analyze the changes that occur from time to time.

Alternating-Current Plants Offer a Complex Problem in Meter Selection

Alternating-current plants present a complex picture in meters and a formidable array of excellent instruments must be judged. The switchboard panels may be arranged and suitable sizes selected to provide for expansion both in numbers of units and possibly a future increase in the number of meters. The exciter panels are often located centrally and flanked on one side by generator panels and on the other side by feeder panels. Sufficient space may be economically provided on the exciter panels for the maximum excitation requirements. However, the generator and feeder panels may be subject to many additions. The exciter panels should be provided with one ammeter for each exciter and a voltmeter for each machine up to two. Where there are more than two exciters, two voltmeters may be provided and the panels equipped with receptacles and plug to use one meter for the busbars and the other for any incoming machine.

Before the generator and feeder switchboard layout is made the following data should be assembled in

order that the proper meters and instrument transformers may be specified:

ALTERNATOR

Voltage, operating.
Phase, number.
Frequency, cycles.
Kw. at rated power factor.
Kva., continuous at guaranteed temperature rise and at overload rating for given period.
Amperes at rated load.
Field current to give maximum permissible temperature rise in field coils.
Voltage on field coils to give maximum permissible current.
Winding type, whether grounded neutral is used (to determine if neutral ammeter and differential protection required).
Brake horsepower, maximum of prime mover.

FEEDERS

Amperes, maximum circuit designed for.
Voltage.

EXCITERS

Number of units, ultimate voltage range whether hand or automatic regulated.
Kw. rating.
Amperes.
Control voltage, where electric operation of switches and pilot lights is provided (charging set meters where necessary).
Auxiliary power voltage and amperes where direct-current house service is used. Alternating-current watt-hour meter should be used in house-service feeder.

The necessary alternating-current switchboard instruments for generator units are the indicating wattmeter, ammeter, voltmeter, frequency meter and synchroscope. The two instruments last named are often mounted on a swinging bracket at the end of

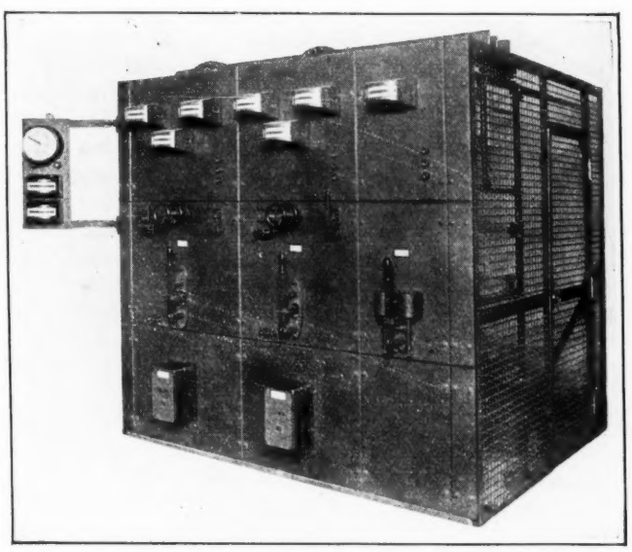


Fig. 1—Synchroscope, voltmeter and frequency meter mounted on a swinging bracket at left end of switchboard

the switchboard so that they are always in view of the operator, as in Fig. 1. Two plugs operating the synchroscope are provided on each machine panel. The frequency meter may be provided with a receptacle connection on each panel, but more often it is connected permanently to the main busbars. Two voltmeters, at least, should be provided, one for the busbars and one for the incoming machine, the busbar voltmeter being connected permanently to one phase and the machine voltmeter being provided with an 8-point receptacle on each panel so that the voltage of each phase may be read. One ammeter may be used to read the current in each phase by installing a three-way ammeter switch. A polyphase indicating wattmeter is essential in order to secure proper load division between units, and the ammeter serving to fix the upper limit of the load.

The range of the voltmeter should be chosen so as to throw the normal reading at about 80 per cent of full

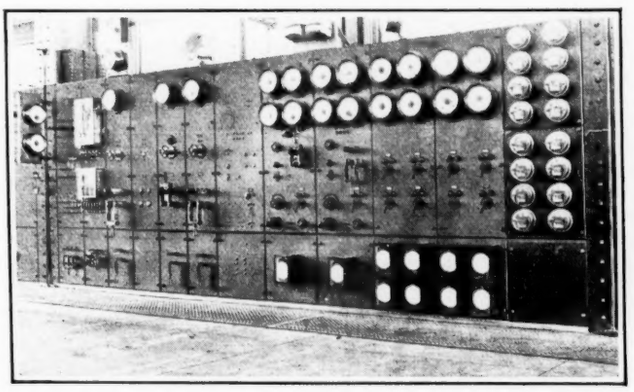


Fig. 2—Exciter panels on the left, generator panels in the center and feeder panels on the right

scale. The ammeter range should be chosen so that at maximum load the reading will be between 60 and 85 per cent full scale. However, since the ammeter is usually of 5-ampere capacity and used in connection with a current transformer, it is necessary to consider both the meter scale and the transformer ratio. The scale of the three-phase wattmeter having 5-ampere current coils and 110-volt potential coils will register about 1,000 watts at unity power factor in the meter circuit. Therefore the primary power scale selected must recognize the operating power factor and the ratios of both current and potential transformers. The current transformer ratio should be such that not over 5 amperes will flow in the standard meter circuit at the operating power factor. The method of approximately determining the scale for a three-phase circuit at power factors of 80 to 90 is as follows (using a factor of 2 instead of $\sqrt{3}$ in the usual formula):

$$\textit{Scale Range} = \frac{R_C R_P E I \times 2}{1{,}000}$$

where R_C equals the current-transformer ratio, R_P equals the potential transformer ratio, E equals the volts applied to the meter and I the ampere capacity of the current coils in the meter, usually 5.

METERS THAT SHOULD BE PROVIDED ALTHOUGH NOT ESSENTIAL

Other meters which are not essential but which should be provided in many cases are the indicating power-factor meter, field ammeter, temperature indicator. The power factor at which the generator operates determines whether or not it may be loaded to its rated capacity. The power-factor meter will also indicate whether the synchronous equipment on the line is operating at the proper corrective value. The balancing of load and excitation on various units may be guided by the power-factor meter. The field ammeter is probably the least utilized meter of the switchboard group; it is of chief use to show when the field current approaches a value that would over-

heat the field winding. In case the potential fuses blow, the field ammeter and alternating-current ammeter may be used to regulate a unit until the fuses are replaced. Temperature indicators are in wide use on turbo-alternators and waterwheel generators where ventilation is a problem and the operating temperatures are relatively high.

The watt-hour meter is not essential when considered from an operating point of view, but it is indispensable from nearly every other angle. It is necessary for obtaining a record of machine and station output, which is of importance whether the power is sold or used by various plant departments. Practically all power costs are based on the kilowatt-hour output. Where the generator output is metered, the summation of the plant department meters gives a means of a perpetual check on the line or transmission losses as well as proving the meter readings and detecting meter failures.

The selection of a recording voltmeter must be dictated by local conditions. The convenience of such a meter in checking voltage regulation, system interruptions and poor operation would indicate that this meter should be installed more frequently than it is. In most cases the recording voltmeter is installed after the plant has been in operation some time and the need for it has been demonstrated. Provision for the installation of this meter should at least be made in the original layout.

The larger plants having a number of units find it necessary to use a recording frequency meter in order to correct poor governor action and to insure that the frequency remains normal. In case of loss of load or other trouble the frequency recorder gives a good record of the action of the governors in closing down units.

Direct-Current Auxiliary Power Switchboard

The direct-current auxiliary-power board is ordinarily separate from the main switchboard, but often a voltmeter receptacle is provided for taking the voltage and an ammeter should be provided for the main board. In the case of alternating-current auxiliaries it is seldom necessary to provide ammeters or voltmeters since the voltage is ordinarily uniform and only in special cases would the ammeter indicate the load. For the feeder to the auxiliary load a watt-hour meter may be provided and daily readings of this meter will serve a real purpose in checking irregular conditions. An ammeter is often used to indicate the current values reached on the feeder circuit.

Each alternating-current feeder panel should be equipped with an ammeter with a three-way ammeter switch for giving a current reading for each phase. Quite often a condition may be met where a watt-hour meter should be installed for each feeder; at other times the installation of a recording wattmeter should be made. A study of plant load curves and of group and individual motor tests will indicate the loads, which may vary at long intervals and the necessary information concerning such a load may be obtained from a watt-hour meter. Where a feeder is subject to definite load cycles or erratic variations of load, it seems essential to provide a recording wattmeter in order to detect irregular operation as soon as it occurs and correct it before damage is done.

After the selection of the proper switchboard instruments and the number of them per circuit, some attention must be given to the type of instrument transformers to be used. The function of the transformer is to eliminate from the switchboard any potential exceeding 115 volts. It is an added convenience to translate the heavy and varied current values to a standard denominator of 5 amperes for all meter and relay coils. The primary circuit determines the ratios of voltage and currents to be used and the insulation to be provided on the transformers. The number of instruments and the accuracy demanded determines the type of transformer to be used. In designing the installation a No. 2 B. & S. ground wire should be provided to ground the case of the transformers and the secondary leads should be suitably grounded by a No. 12 conductor in order to protect the switchboard in case of insulation leakage or breakdown.

Selection of Instrument Transformers

The transformers are furnished in various ratings based upon the secondary load to be connected, known as the secondary burden; this is the combined volt-ampere load determined from the connected meters. The better grades of current transformers are compensated for a certain volt-ampere secondary load, and such transformers should be accurate within 0.5 per cent at their rated burden and between 25 per cent and 150 per cent normal primary current. In computing secondary burden the necessary information must be obtained from the makers for each general type of meter unless already known. Where over four meters are connected in the secondary circuit of a current or a potential transformer and where the current leads exceed 100 ft. of No. 10 B. & S. wire (200 ft. of wire), the installation should be checked with the instrument transformer maker in order to determine if the ratio and phase-angle characteristics of the transformer will exceed the standard limits. The phase displacement may be disregarded where the compensation is sufficient for the burden. Where the phase angle is increased abnormally by too great a secondary burden or by a low secondary-load power factor, the ratio and phase angle curves supplied by the maker for the transformers should be consulted to determine if the accuracy of the meters may be impaired and if so more suitable transformers should be obtained or an additional set of transformers installed and the meter load divided. Quite often it is necessary to operate induction relays and tripping devices. Phase angle affects only meters having both voltage and current coils.

The average potential transformer is compensated for about three average meter voltage elements or about 15 volt-amperes and about 50-ft. leads of No. 10 B. & S. wire (100 ft. wire). Potential transformers should never be subjected to excessive voltages which greatly increase the iron losses and they should never be connected to a circuit of lower frequency than rated. Frequency is of less importance with current transformers, but they should be calibrated on the frequency to be used.

The general use in large stations of either the auxiliary generator or the spinning house-generator as a reliable source of power for essential auxiliaries has been introduced during the last year. The tendency is still for the great majority of auxiliaries to be motor driven, although one company is equipping all auxiliaries with efficient small turbines.—*Prime Movers Committee of N. E. L. A.*

Copper and Brass in the Power House*

By W. G. Schneider
Copper and Brass Research Association

As ONE opens the door of a power house that neat, natty appearance, together with the hum of machinery, extends a welcome that is more appealing than in any other part of the industrial plant. This attractiveness and pleasing of the eye is to no small extent due to the framing of the picture with brass. The brass railings and other brass trim offset to a large measure the grim plainness of the moving giants. Brass, however, has many other uses in power plants than just as an ornament or railing; in fact it might be said that without copper, brass, bronze or other copper alloys power plants today, such as they are, would not be in existence.

A brief description of a few alloys used for bearings may be of interest:

Copper	80%	Used for low or medium speeds
Tin	19%	against hard steel surfaces for bear-
Phosphorus	1%	ing pressures in excess of 1,500 lb. per sq.in. Recommended for pivot blocks, heavy-duty thrust bearings and similar service.
Copper	84%	Used for low speeds at pressures not
Tin	16%	exceeding 1,500 lb. per sq.in. It may
Deoxidized with Phosphorus		be used for thrust bearings and washers, trunnions, journals of lift bridges, guide bearings for push rods in gasoline engines.
Copper	86 %	May be used for the bearings of
Tin	9.5%	many types of machinery at average
Lead	2.5%	loads and speeds.
Zinc	2.0%	
Copper	80%	*Sand Cast*
Tin	10%	Recommended for locomotive cross-
Lead	10%	head and crankpin bearings, roll neck
Deoxidized with Phosphorus		bearings; lathe bearings, grinder bearings and all machinery bearings where the journal speed is high or where the journals are not heat treated.
		Chill Cast
		Reduces the grain size of the alloy, and develops higher anti-frictional qualities also increasing its resistance to repeated shock. Suitable for bearings of internal combustion engines.
Same Alloy		*Centrifugally Cast*
		More evenly distributes the lead. Recommended for the backing of bronze babbitt-lined bearings where inside, outside and flange bearing value is required.
Copper	79.50%	Relatively hard bearing metal.
Tin	12 %	Recommended for bearings where the
Lead	7.50%	journal is very hard. Suitable in
Phosphorus	1 %	camshaft bearings and push-rod guides. Should not be subjected to severe shock or hammering.
Copper	78%	Very good alloy for bearing purposes.
Tin	8%	Proved suitable in mill bearing spin-
Lead	14%	dles where spindle is soft steel and
Deoxidized with Phosphorus		speed is relatively high. Journal bearings.
Copper	83%	Has proved remarkably satisfactory
Tin	6%	in a wide diversity of bearings. In
Lead	9%	machine tools where speed is not
Zinc	2%	excessive this alloy will give lasting satisfaction.
Copper	90 %	Recommended for the backs of bab-
Tin	6.5%	bitt lines, bronze sheels and for
Lead	1.5%	heavy-duty steam work.
Zinc	2 %	

*Excerpts from paper before national convention of the N.A.S.E., St. Paul, Aug. 31 to Sept. 4.

In connection with condenser tubes, where the water is fresh the tube may be produced from an alloy containing from 59 to 66 per cent copper with the balance zinc. Where, however, salt water or seawater is used such an alloy will not prove satisfactory and admiralty mixture, 70 per cent copper, 29 per cent zinc and 1 per cent tin, or brass containing 79 to 85 per cent copper balance zinc is used.

Brass and bronze are extensively used throughout or as trim and fittings for all kinds of valves, injectors, whistles, cocks, priming cups, grease cups, lubricators and similar equipment which form part of any and all power plants. An alloy of copper 88 per cent, tin 10 per cent, zinc 2 per cent is satisfactory for steam valves, and is extensively used for this purpose. As in the case of bearings the best valves and fittings are those produced from pure metals rather than from scrap of unknown composition. It is always advisable to purchase such material from recognized manufacturers rather than from someone not so well known who may not have the proper facilities to keep all the necessary operations under that laboratory control so essential to the production of metal products.

The Flow Measuring Nozzle

By A. J. Nicholas

THE use of the flow measuring nozzle in the fields of steam meters and steam turbines and as a measuring device for determining rated capacities of compressors, is important and extensive. This is due in great measure to the science of thermodynamics, which furnishes us with an accurate means of calculating the discharge of compressible fluids through nozzles.

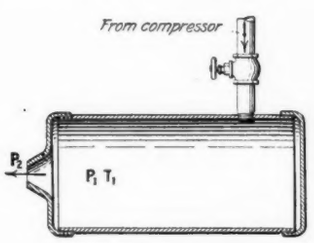


Fig. 1—P_1 constant

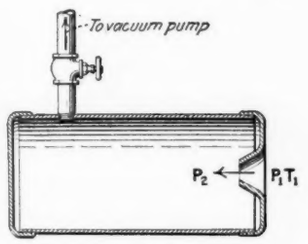


Fig. 2—P_2 constant

Rigid thermodynamic analysis shows two forms of flow through a nozzle for compressible fluids, each form having its own formula. One is defined from the other by a certain pressure-ratio condition. This is a throat condition of the nozzle and is of different value for different fluids.

As a point in question let us, then, consider the flow of air (a representative type of a compressible fluid) through a nozzle. The equations expressing the two forms of flow mentioned, are:

$$W = \frac{2.044 a P_1}{\sqrt{T_1}} \sqrt{\left(\frac{P_2}{P_1}\right)^{1.422} - \left(\frac{P_2}{P_1}\right)^{1.711}} \qquad (1)$$

and

$$W = \frac{0.533 a P_1}{T_1} \qquad (2)$$

in which

W = Weight of discharge in lb. per sec.;
P_1 = Absolute pressure in lb. per sq.in. before the nozzle;
P_2 = Absolute pressure in lb. per sq.in. after the nozzle;
a = Area in sq.in. of throat of nozzle;
T_1 = Absolute temp., deg. F., of air before the nozzle.

Equation (1) applies to the conditions of flow when the ratio of P_2 to P_1 is greater than 0.53 and equation (2) when it is less than 0.53. The critical pressure ratio is 0.53 for air.

Let us graphically represent the discharge as calculated by equations (1) and (2), for a given nozzle and for a complete pressure-ratio range. Suppose the conditions of flow are as shown in Fig. 2. The pressure P_1 is constant, and P_2 is varied by the suction of the vacuum pump. The portion MN of curve 1, Fig. 3, is found by using the equation (1) and NO by using equation (2). This curve indicates that the flow is constant and a maximum for the given nozzle area and the constant initial pressure P_1 when P_2 is 0.53 P_1 or less.

If we now increase the pressure P_1 to some other value and keep it constant, and vary the back pressure P_2, using the same nozzle as before, the plot of W against

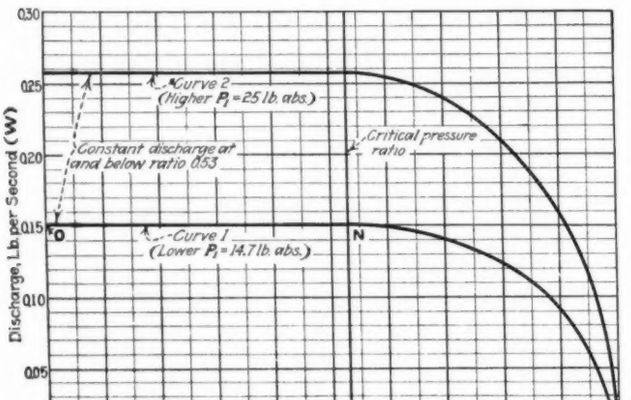


Fig. 3—Type of curves obtained when initial pressure is constant and back pressure is gradually increased

the ratio of pressures would give curve 2, Fig. 3, which is similar to curve 1.

It is evident, then, that for a constant initial pressure and a varying back pressure, the graphic representation of discharge through a flow nozzle will give a family of similar curves, such as 1 and 2 of Fig. 3.

Suppose we now consider the flow through the same nozzle as above, but arranged as in Fig. 1. The discharge takes place from the receiver through the nozzle into the atmosphere. Again, let P_1 represent the initial pressure and P_2 the final pressure. Suppose P_1 is varied and P_2 is kept constant, a condition that often occurs in practice.

The discharge W, as calculated from equations (1) and (2), when plotted against the pressure ratios, gives curve 3, Fig. 4. The portion AB is calculated from equation (1) and BC from equation (2). Portion AB of curve 3 is similar to portion MN of curve 1. However, BC and NO are not similar, yet each was calcu-

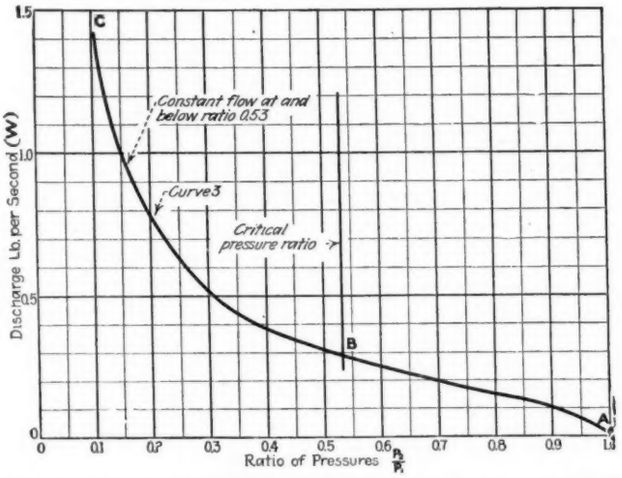


Fig. 4—Curve obtained with constant back pressure and decreasing initial pressure

lated from the same equation. In the case of NO the discharge W is a maximum and constant. In the case of BC the discharge is a maximum but not constant.

The discrepancy in graphic representation of flow as seen from NO and BC is only apparent. It will be noticed that NO was found for a fixed initial pressure P_1. In the case of BC the initial pressure P_1 varied. Examination of equation (2) shows that at the critical pressure and below it the flow depends entirely on the initial pressure P_1. Hence, if P_1 is constant, as in the first case, any reduction of P_2 below ratio 0.53 will not affect the flow, and the flow will be constant and a maximum as shown by NO.

With the conditions of flow as in Fig. 3 any increase in pressure P_1 beyond the point where $P_2 = 0.53\ P_1$ will give a locus of maximum discharge as shown by BC, since P_2 no longer has any influence on the flow, just as equation (2) indicates.

However, the flow is constant and a maximum for a given constant initial pressure. That is, if some initial pressure P_1 were taken and kept constant, while the back pressure P_2 was varied, exactly the same type of curve would result as in Fig. 3. BC is the locus of constant maximum discharges for varying initial pressures.

In the case of flow of steam through nozzles, using appropriate equations, the graphic representation of discharge would be similar to Figs. 3 and 4, for the same types of arrangement. The critical pressure ratio, however, would be 0.58 for wet steam, and 0.55 for superheated steam.

The latent heat of evaporation of water decreases as the pressure increases. Starting with 970.4 B.t.u. per pound at atmospheric pressure, it falls to 837.9 at 200 lb. gage. It hits the even thousand, practically, at 5 lb. absolute. The total heat of (saturated) steam, being the sum of the heat of the liquid, which increases with the pressure, and the latent heat varies but little.

Regulation of Pump Output

Discussion of Types of Pump Governors—Suggestions as to Methods of Installation

BY CHARLES L. HUBBARD

IN DECIDING upon the proper device to regulate the capacity of a pump to meet varying operating requirements, a careful study should be made of the individual case in order to install that regulator which is most suitable.

The types of pumps commonly employed about the power plant include the direct-acting steam, the power, the centrifugal, the rotary and certain special forms

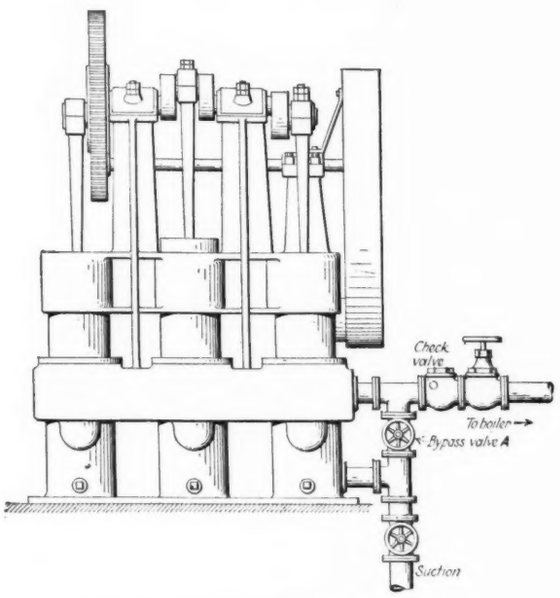


Fig. 1—Power pump with bypass

of pumps for condenser-air service and other vacuum work. There are many instances where hand regulation gives satisfactory results, especially in cases where the pumping capacity required is fairly constant or the pump must be started and stopped at rather infrequent intervals. Where constant pressures must be maintained, as in elevator service, or where the capacity of the pump must be frequently varied, as in boiler feeding with automatic regulators, it is necessary to employ pump governors, for one cannot regulate closely enough by hand.

Boiler Feed Pump Regulated by Hand

Boiler-feed pumps of the direct-acting steam type usually are regulated by hand in small plants. This arrangement, however, is only adapted to cases where the load is practically constant or the changes comparatively small. The pump should be located near the boiler and the valve in the steam pipe placed so that the fireman may have a good view of the gage glass while regulating the pump speed. The temptation in hand feeding is to pump considerable quantities of water intermittently rather than to run with a continuous feed. This is liable to strain the joints, due to unequal expansion and contraction, and to check evaporation when the load increases and steam is most needed.

Valved Bypass Used Between Suction and Discharge Valves

An arrangement sometimes used in connection with power and motor-driven pumps, is that shown in Fig. 1 where a valved bypass connects the suction and discharge pipes. By opening the valve *A* the pump discharges back into the suction. When the bypass valve is opened wide, so that no pressure is created in the discharge pipe, this method may be more convenient in some cases than stopping and starting the pump. The objection to a bypass valve is its frequent use as a regulating valve. This makes the arrangement open to the fault that the pump must work at full load regardless of the quantity of water delivered to the boiler, because the pressure in the pump discharge pipe must always slightly exceed the boiler pressure. It is generally best, when using a bypass,

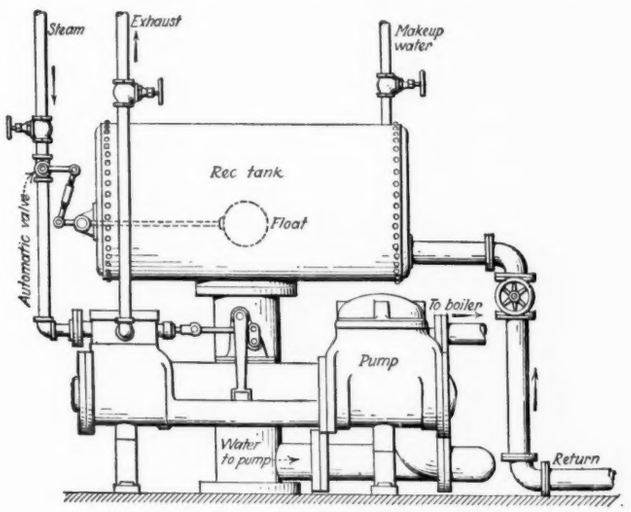


Fig. 2—Arrangement of receiver and pump

to install an automatic governor designed for this special purpose.

Another case of hand regulation is where practically all the steam, both exhaust and live, is condensed in a heating system and the return brought to a receiving tank, from which it is pumped to the boiler. The best plan is to use an ordinary automatic pump and receiver, maintaining a uniform water level in the tank by means of a float, which in turn actuates a valve in the steam pipe to the pump, as shown in Fig. 2. The makeup water is admitted to the tank from time to time by means of a hand valve. When a large part of the exhaust is used for other purposes and the condensation turned into the sewer, or where the heating

requirements are such that the returned condensation is less than the makeup water, it is usually best to let the automatic float valve in the receiver control the makeup water, and regulate the boiler feed-pump by hand.

Hand regulation is also employed where pumps are used for filling elevated tanks, when it is permissible for the water level to fluctuate considerably. In case the pump is started and stopped by hand, there should be an indicator provided, which will show the water level in the tank, or at least the high and low limits.

Auxiliary and Circulating Pumps

Auxiliary pumps used in connection with condensing apparatus require but little change in capacity and are run at practically constant speed. When the circulating pump is equipped with electric drive, it is usually operated at near its normal capacity and any changes necessary taken care of by a supplementary turbine-driven unit.

If condensing engines or turbines are subjected to wide fluctuations of load, either steam drives must be used for the condenser pumps, so that the speed can be changed, or supplementary units must be cut in or out. In general, the condenser pumps are operated at a capacity approximating the maximum load on the prime mover, and allowed to work at a higher capacity than necessary during temporary periods of turbine underloadings. At small overloads, if of short duration, the efficiency of the prime mover may be allowed to fall off

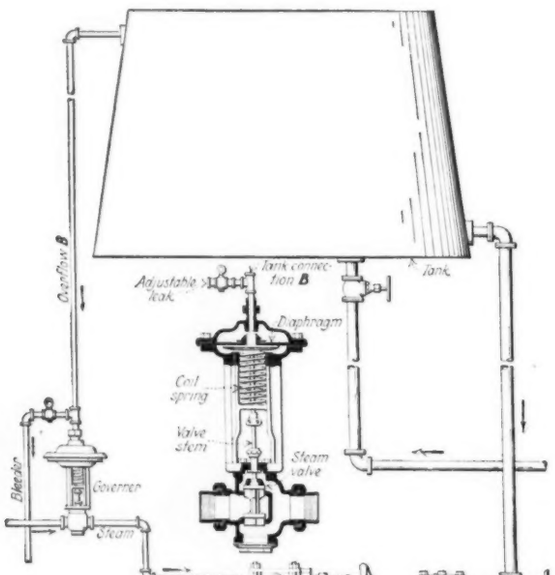


Fig. 3—Arrangement to control tank pump

slightly owing to a decrease of vacuum. Load variations of any considerable amount or duration call for a corresponding adjustment of the condenser pumps.

The exacting operating requirements of modern power plants call for more accurate pump regulation than can be secured by hand control. In the following description, diagrams illustrating the principles involved will be used for the most part, in place of detailed drawings of special makes.

Altitude valves or governors, for automatically maintaining a nearly uniform water level in elevated tanks, operate in different ways. The device shown in Fig. 3 is placed in the steam supply to the pump and the space above the diaphragm connected with the tank at the desired water level. When the water reaches this point, it overflows into pipe *B* and soon rises to a level where

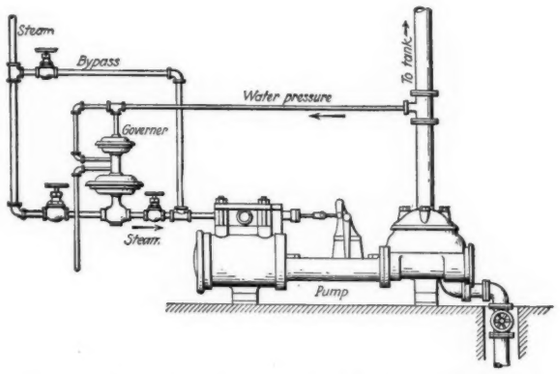


Fig. 4—Governor is operated by water pressure

the weight of the column acting on the diaphragm is sufficient to overcome the tension of the spring below it, and closes the steam valve, thus stopping the pump. Just above the governor is an adjustable bleeder, which is set to leak slowly. When the water level in the tank falls below the overflow connection, the leaking of the water from the pipe bleeder relieves the pressure on the diaphragm, thus allowing the steam valve to open and start the pump.

In another form the discharge pipe leading from the pump to the tank is connected with a diaphragm governor, so designed that when the water level reaches the desired maximum, the pressure on the diaphragm actuates a small pilot valve, which in turn, admits full water pressure to a larger diaphragm whose movement closes the valve in the supply pipe and so shuts off the flow to the tank. When the water level falls slightly, the reduction in pressure on the smaller diaphragm actuates the pilot valve in such a manner as to exhaust the water from above the larger diaphragm, and so allows the main valve to open and again admit water to the tank. When this device is used in connection with a steam pump, it is placed in the steam pipe, as in Fig. 4. The action is the same as before, except it cuts off the flow of water to the tank by stopping the pump.

Pump Governor Required for Maintaining Vacuum in Main Return Line

Heating systems operating on the return-line vacuum principle require a pump governor for maintaining a uniform vacuum in the main return line. The general principle involved in this case is the same as with the pressure type of governor, where the pressure in the discharge pipe is greater than that of the atmosphere. A vacuum governor is shown in Fig. 5. The space below a flexible diaphragm is connected with the return line, and the difference in pressure betwen the desired vacuum and the atmosphere is balanced by an adjusting weight and lever. When the pressure in the return line rises above the point for which the governor is set, the diaphragm is lifted, and by means of side rods, opens the steam valve and speeds up the pump sufficiently to bring conditions back to normal.

Practically all modern plants are equipped with automatic feed-water regulators, and pump governors form an essential part of this equipment. In a general way, regulators of this kind may be divided into two classes —those maintaining a practically constant level in the boiler regardless of the load, and those which cause the water level to vary with the steam demand and allow the boiler to operate with a low level under heavy loads and with a high level at light loads. Both classes make use of an automatic regulating valve in the boiler-feed pipe, which is opened and closed by the regulator, according to the demand for water. It is evident that when this valve is throttled or closed, the pressure in the pump discharge will rise, and the pump should be slowed down or stopped at such times, according to operating conditions.

The regulators that are shown in Fig. 6 are designed for this purpose, and are known as *pressure* and *excess-pressure* regulators, respectively. The regulator *A* is designed to slow down the pump when the pressure in the discharge pipe rises above the normal, and to stop it entirely when it reaches the maximum

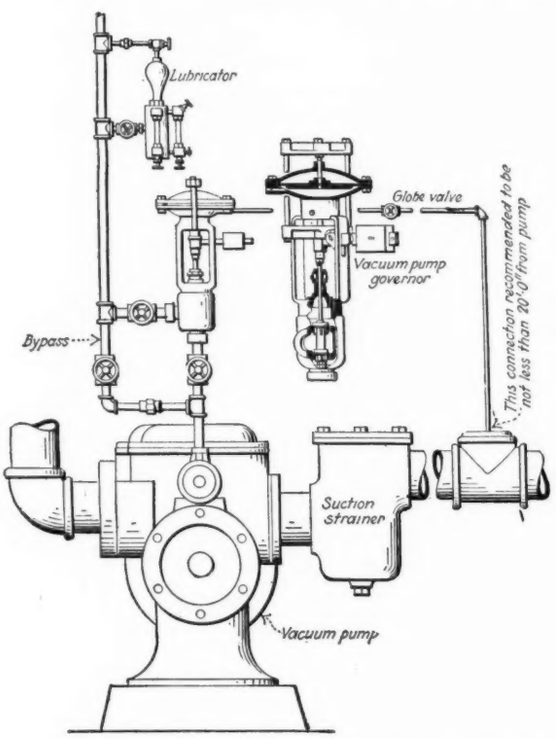


Fig. 5—Regulator for vacuum heating system

for which it is set, regardless of the pressure in the boiler. In operation it is connected into the steam pipe to the pump, or turbine if it is of the centrifugal type, and the space above the piston *D* connected with the discharge pipe. When the automatic valve in the feed line is closed by the regulator, the continued action of the pump causes the pressure in the discharge pipe to rise until it reaches a point where it is sufficient to overcome the tension of the spring and close the steam valve by forcing down the piston *D* and so stopping the pump. When the feed valve opens, the conditions are reversed and the pump starts automatically.

The excess pressure valve *B*, in Fig. 6, operates in practically the same way, but is designed to maintain a uniform pressure difference between the boiler and the pump discharge, regardless of what the boiler pressure may be. In this case the steam valve to the pump is balanced by the steam and water pressures acting upon the top and bottom, respectively, of the piston *C*. The excess pressure it is desired to maintain in the feed line is obtained by an adjusting weight which tends to keep the valve open until the excess pressure in the feed line is sufficient to overbalance the weight.

On the other hand, when a hydraulic elevator is started, the pressure in the tank begins at once to fall,

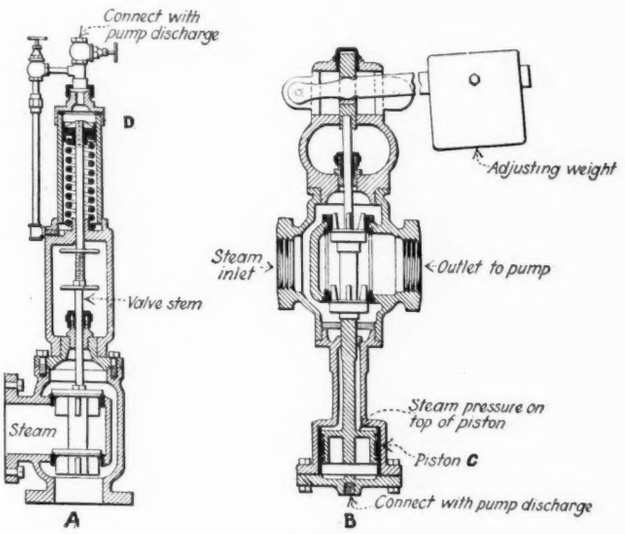


Fig. 6—Types of boiler feed pump regulators

and the pump must immediately respond and bring the pressure up to normal, and maintain this condition throughout the trip of the car. This calls for a very sensitive governor and one which will give at once a full opening to the steam valve.

The valves of any type or make of machine are the most sensitive parts, and the greatest of all losses in refrigerating capacity is caused by valve trouble. Such trouble may be leaks, improper spring tension, sticking, breaking, derangement of parts, or restricted passages. For an ammonia compressor to do its full duty and so handle the proper weight of gas the valves must be gastight, of sufficient area, easy and quick in operation, and the springs must offer the least resistance possible. Scale and grit will cause the compressor valves to leak, stick and break. Small particles of scale from the inner surface of pipework, passing through the valves, will soon cut the seating surfaces, and then the gas will leak through. Pieces of scale or fine grit getting between the stem and the guide will make the valve stick, and this often causes the valve stem to break or bend.

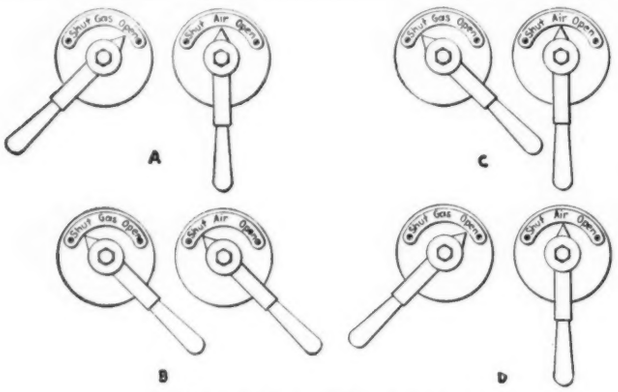
The Technical Report of the British Engine, Boiler and Electrical Insurance Co., Ltd., of which Michael Longridge is chief engineer, after describing three cases in which stripped blading was found in turbines when opened, remarks: This and the two preceding cases exemplify the value of the recommendation of the company that a turbine be opened out at least once a year for examination. It is by no means uncommon, on a turbine's being opened, to find that the blading is damaged.

Avoiding Preignition Troubles in Gas Engines

By H. Weiland Los

It is well known among gas-engine operators that preignition in gas-engine cylinders is unavoidable when the engine carries a fluctuating load and the combustion chambers contain an excess of carbonized oil and grit.

On the other hand, steady-loaded engines are not liable to early ignitions, because the adjustment of gas



Setting of air and gas valves

A, normal position; *B*, position when preignition sets up; *C*, at this position preignition ceases; *D*, final setting of the cocks.

and air can be made in such a way as to insure a full charge, a high compression pressure and a high combustion temperature. As a result, oil and dust do not get a chance to collect, but are partly burned and swept out along with the exhaust gases. Of course a steady load is most desirable in the prevention of preignitions, but ideal conditions do not reign in the average power plant.

One engineer took charge of a producer gas engine of the graduated-governing type which was sometimes subjected to a light load during the day. The engine has caused trouble for years and the best one could do was to increase the air supply when the engine showed signs of distress. As a matter of fact, this manipulation was promptly followed up by a series of heavy shocks, caused by the abnormal rapidity of propagation of flame, often bringing the engine to a standstill. As a rule the engine caused the most trouble when a rush order had to be put through the factory and no time was available for cleaning piston and combustion chamber.

The new engineer modified the operating procedure in order to keep the engine in operation even if conditions were unfavorable. During normal operation the gas and air cocks were adjusted as indicated at *A* in the illustration. When the engine started to pound, the half-compression roller was shifted to the low-compression position and the air and gas supply was throttled, as shown at *B*, in order to smother combustion and relieve the engine entirely from shocks. In the meantime the normal load was held on the engine.

After some time the engineer set the air cock back to its normal position, being careful to avoid shocks, and then the gas cock was opened entirely. Having attained this end, the half compression roller was slipped out and operation became normal again.

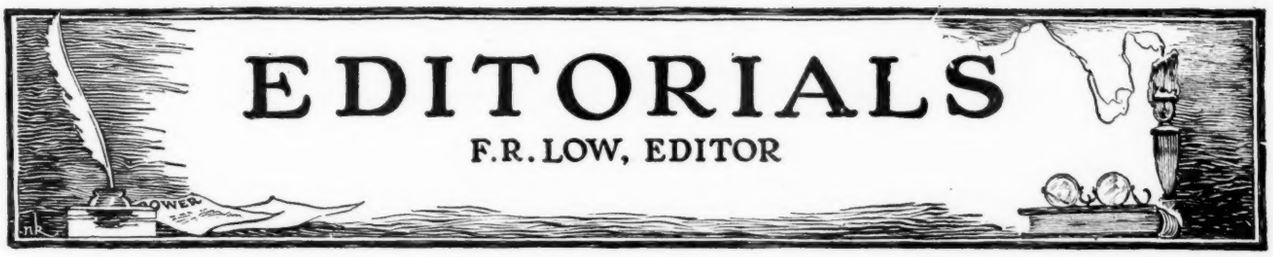
Sometimes it took an hour before the engine was sufficiently cooled down, and during that period even a 5-deg. turn of the air-cock plug would cause severe pounding, so readjustments were made very carefully.

This engine runs 60 hours a week and the piston is pulled only twice a year. Filtered oil is used for the piston lubricating, and although the supply has been doubled, a preignition is at present an exception.

Heating and Ventilation Systems Employed in Several Large Stations*

Station	Calumet	Kearney	Trenton Channel	Cahokia	Waukegan	Hales Bar	Devon	Weymouth	Somerset	Wabash River
Company	Commonwealth Edison Co.	Public Service Electric Co.	Detroit Edison Co.	Union Elec. Lt. & Power Co.	Waukegan Generating Co.	Tennessee Electric Power Co.	Connecticut Lt. & Power Co.	Edison Elec. Illuminating Co.	Montaup Electric Co.	Indiana Electric Corp.
Heating Turbine room	None	Blower-heater units	Indirect rad. for windows and roof	Direct rad.	None	None	Direct rad.	Direct rad. at windows	Direct rad. at windows	Direct rad.
Boiler room	None	Blower-heater units	Direct rad.	Direct rad.	Direct rad.	None	Direct rad.	Direct rad.	Direct rad.	Direct rad.
Elec. control rooms	Direct rad.	Direct rad.	Direct rad.	Direct rad. in control room	None	None	Direct rad. in control room	Indirect rad.	Indirect rad.	Indirect rad.
Offices	Direct rad.	Direct rad.	Direct rad.	Direct rad.	Direct rad.		Direct rad.	Direct rad.	Direct rad.	Direct rad.
Gen. Cooling system	Closed	Closed	Closed	Closed	Discharge up into room	Closed	Closed	Closed	Closed	Closed
Turb. room roof Condensation	Insulated Practically none	None Expected	Not insulated None expected	2 in. cork ins. None	Hair felt ins. None	None None	Not insulated None	2 in. "Lith" ins. None expected	2 in. "Lith" ins. None expected	2 in. "Lith" ins. None expected
Ventilation Turbine Room	Enters windows Drawn out by forced draft fans	Natural	Fans and duct to sweep windows and roof Drawn from monitor	Natural	Natural	Drawn along ceiling to boiler room	Natural	Natural	Natural	Natural
Boiler room	Drawn to forced draft fans	Natural	Enters from turbine room and around flue	Enters from windows and from turbine room	Natural	Drawn to forced draft fans	Drawn to forced draft fans	Natural	Drawn to forced draft fans	Natural
Elec. control rooms	Ducts to roof fans and ducts	Fans and ducts	Exhaust fans	Fans and ducts	Natural	Natural	Natural	Fans and Ducts	Fans and Ducts	Fans and Ducts
Offices, etc.	Natural	Natural	Natural	Natural	Natural	Natural	Natural	Natural	Natural	Natural

*From recent report of Prime Movers Committee, N. E. L. A.



Responsibility and Service

BEFORE accepting a low bid or rejecting a higher one, it is the part of wisdom to investigate a number of points. Is the lower-priced apparatus really just as good in every respect? Are equally good guarantees made for it? Is the guarantee to be depended upon? Are its backers fully responsible, or must one go to the courts to make them keep their agreements? This is worth a lot of pondering. Make sure the guarantee is more than a "scrap of paper."

Finally, there is the intangible element of service. Service costs money, but in some lines it is essential to the customer's continued satisfaction. When purchasing equipment of such classes, one should make due allowances for service facilities and practices when comparing prices. The wise purchaser sometimes chooses the lowest-priced article, sometimes the most costly, but he never fails to take into account every known factor affecting the value of what he receives for his money.

Another Coal Strike

WHERE in general, industrial peace and prosperity reign throughout this country, another strike in the coal-mining industry is in full operation. But there is nothing new about this; in fact, the country has become so accustomed to such occurrences that little attention has been given this latest test of strength between the coal miners and operators. Probably the country was never before so well prepared to withstand the effects of such a strike, and if it can be done without too seriously inconveniencing the public, the best course will be to let the operators and miners settle their differences as best they can.

No fair-minded person will dispute the fact that both parties to the controversy are entitled to a fair price for their product and service. However, it is apparent that each side has little regard for the other and less for the public interest. From the start of the present controversy it was evident that both operators' and miners' leaders were more interested in jockeying each other about than in reaching an agreement, in the hope that the public might take alarm and step in to settle the difficulty, as has been done previously, generally to the advantage of both operators and miners. This time they have been left completely to themselves to settle their own differences and may it be with good moral effect.

Should the strike be of long duration, it will certainly have permanent detrimental effect on the anthracite industry. Already substitutes are making heavy inroads into the anthracite business, and cutting off of the supply of this coal cannot help but accelerate the permanent use of substitutes. This should eventually have an effect favorable to the public, and if the strike is carried to a conclusion that will convince the beligerent parties that such procedures are to be avoided rather than indulged in, then any inconvenience that may be suffered to attain this end may be well worth the cost.

Psychological Tests for Engineers

WHILE among many, psychological tests are the basis of good stories, still more and more industrial managements are making use of such tests to determine a worker's suitability to his job. If tests will show this, why not make use of them to determine how a man will react in the time of danger or when snap judgment is required? Why not test engineers in charge of power plants to see if they will act correctly when an emergency arises?

The present-day license examiners do in a small measure endeavor to ascertain a man's mental makeup, but since the candidate can take as much time as he desires, answers to the list of questions represent considerable mental ruminating. Years ago the railroads essayed to check the quickness with which the engineer brought his train to a stop after receiving a signal. On some roads red lamps were displayed at unexpected places and the engineer who ran by one of these signals was duly penalized. Such tests were bitterly resented by the enginemen and ultimately were abandoned.

After all, men upon whom rests the responsibility of running a locomotive, operating a power plant or a steamship should be of a type that remains cool in time of danger and knows how to do the proper thing at the proper moment. Too much stress is laid both by an examining board and by a prospective employer on the engineer's ability to *do* things. Little thought is given to a man's judgment as to *when* to do it. The man who tries to tighten up the flange of a steam main in a plant where a break would spell death to others needs to have his mental poise tested.

To observe how a man will act when a boiler tube suddenly gives way or a turbine loses a few blades should be illuminating. It might be hard on the nerves of the subject, but should result in fewer disasters.

Does the average engineer "react" properly? It is questionable.

Economic Design of Power Stations

As noted in a previous editorial (July 28 issue) the combination of high construction costs and the steady decrease in the fuel consumption per kilowatt-hour brought about a condition where fixed charges equal or even exceed the fuel bill in the typical new central station of twenty thousand-kilowatt capacity or more.

It is therefore fitting that designers should consider more carefully than ever the matter of first cost. Broadly speaking, there are two methods of reducing first cost. One is to use less costly equipment with some sacrifice of dependability and thermal economy. So much hangs on reliability that neither owners nor designers are likely to make appreciable concessions in this respect in order to lower the installation cost a few dollars per kilowatt-hour. In fact, with reliability al-

ready on a high level, the demand seems to be for still more rather than less. Viewing the business as a whole, and evaluating the effect of shutdowns on good will and ultimately on revenue, this attitude is undoubtedly justified.

Where it is merely a question of first cost versus fuel economy, the intelligent choice must always be made by balancing the additional overhead costs entailed by the more efficient design against the obtainable fuel savings. In this matter some designers seem to have paid more than was warranted for an extremely low B.t.u. consumption per kilowatt-hour, while others have not taken full economic advantage of fuel-saving possibilities.

A third class of investment savings can be made without sacrificing either dependability or thermal efficiency. Failure to explore and utilize such possibilities to the full cannot be excused. Reference is made to such matters as the selection of sites capable of being developed at a minimum cost, the arrangement of apparatus in a manner calculated to save building costs by avoiding undue volume and floor space per kilowatt, expensive foundations, excavations, etc., and the keeping down of interest charges during construction by the avoidance of delays due to lack of foresight. These and many related matters are discussed by Messrs. Vehling and Crawford in the article on page 357. The possible savings include many small items, but the total is impressive. The authors estimate that, by careful utilization of known and available principles, an average reduction of twenty-five per cent may be made in first cost without sacrifice of thermal efficiency or reliability. Even the best existing performances can, in their opinion, be bettered by ten per cent in this respect.

In view of marked ability of the firms engaged in the design of the large stations, some may question the accuracy of these figures, but whatever the possible saving may be, there can be no doubt that the article referred to contains many money-saving suggestions.

Making the Greatest Saving

IT IS generally recognized that there are many classes of industrial loads that can be more economically served by purchased power than from an isolated plant. On the other hand, it is equally true that there are industrial loads that can be supplied more economically from a properly designed and operated isolated plant. Proper design and operation are important factors in the economy of any plant, and the industrial plant is no exception. It must be designed for the type of load to be served and operated by men who are capable of getting results.

Frequently, a plant is shut down and power or both power and the steam for heating purchased, at what appears to the management to be a saving, where a similar load in another establishment is served by an isolated plant. There are cases on record where the power and heating requirements are supplied at less cost from the isolated plant than the power alone could be purchased. The chief reason for these contradictory conditions is that in the former the plant is not properly designed or operated, or both, where in the latter the equipment is suited to the load and is operated by engineers who know how to get results.

To the management of an establishment who is considering shutting down his power plant and purchasing power, there is more to be considered than the question of which is cheaper, to operate the plant as it is or to purchase power. Too frequently, the issue is decided on shutting the plant down only. Although the change may result in a saving, if the owner of the plant had gone farther into the problem, he might have found that a far greater saving could have been made by making changes in the plant design and employing the proper type of men to operate it. This generally can be decided only by employing a competent and unbiased engineer to report on the whole problem.

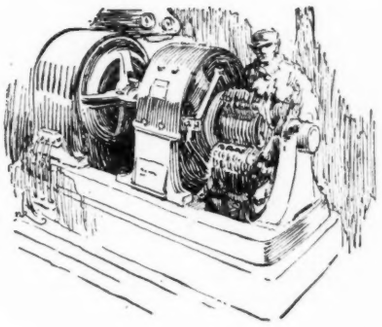
The owner of the manufacturing plant has money invested in a power plant, and the first question should be, can this plant be operated in a way to compete with purchased power? If it cannot under present conditions, can it be changed to do so and will the saving warrant the cost of remodeling? If this cannot be done more economically than purchasing power and generating steam for heating or purchasing both, then of course the latter procedure should be adopted. But the whole question should be decided by a competent engineer on its economic merits and not on any existing conditions in the plant. If the conditions in the plant are wrong, then the comparison drawn between generating and purchasing power should be made on a basis of a properly designed plant. Unless this is done, an opportunity may be lost to operate the power plant at a far greater saving than can be obtained by shutting it down and purchasing power. If the real economies of the whole problem were thoroughly gone into in all cases, a lot of plants that have been shut down would still be in operation and probably some that are still in operation would be shut down.

Selecting Meters for Their Utility

WHEN selecting meters, their utility should be given first consideration, since a meter that has only ornamental value soon ceases to be ornamental due to neglect. It is a fine thing to have a good-looking switchboard in the plant with a lot of meters on it, but unless intelligent use is made of them their cost might better have been saved or the money put into some other equipment that would be used. The choice of instruments will depend on the size and importance of the plant. The electrical end of most any plant may be run with one voltmeter and an ammeter for each generating unit. But economical results cannot be expected with any such a limited equipment. In the direct-current plant the selection of meters is comparatively simple, but as pointed out in the article, "Switchboard Meters for Power Plants," the alternating-current plant presents a more complex situation with a wide range of instruments to choose from.

In any plant the watt-hour meter is essential for obtaining a record of the energy output of the station. Where departmental records are kept and power charges are made to each department, a watt-hour meter on the feeders going to each department will many times justify its cost. If each department is charged for the actual power used and not a proportional part of the total, those responsible for the department will generally see that the power consumption is kept as low as possible, and the savings that have been obtained in this way have in some cases been surprising. The economic value of recording meters is frequently lost sight of, but when their records are used intelligently they have practically unlimited possibilities.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for July will be announced this month.

Improved Floor Stand for Use With Concrete Floors

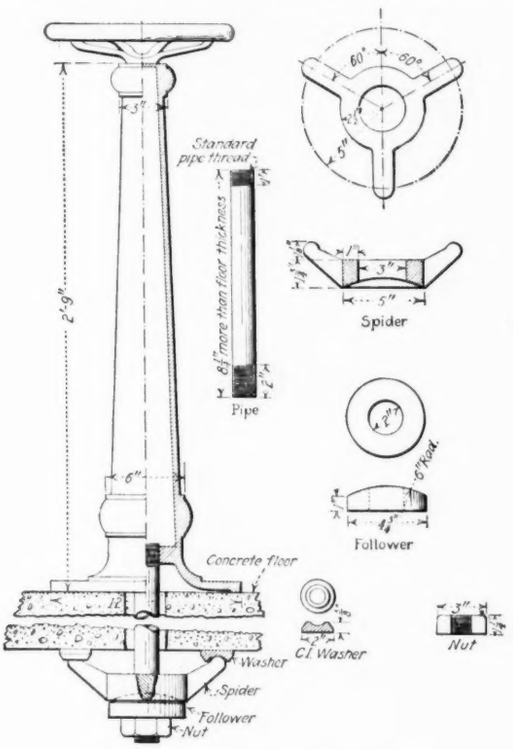
The accompanying drawing illustrates a departure in the design of floor stands for valve operation used in connection with concrete floors. It has two distinct advantages. It does not require the drilling of the floor for expansion bolts or through bolts and it can be easily adjusted to the proper position over the valve and easily and securely fastened in place by tightening up one nut.

The difference in the stand itself is the lack of bolt holes in the foot and the addition of a web near the bottom cast integral with the stand. The center of this web is cored and the hole tapped with a standard pipe thread into which is screwed a 1½-in. special length nipple long enough to extend 6 in. below the concrete floor. On the end of the pipe nipple, opposite to that screwed into the web of the stand, is cut a standard pipe thread, without taper, two inches or more in length.

The device for actually fastening the stand to the floor consists of a tripod or "spider" having a recess in the top in the form of a spherical segment with a follower forming with the spider a spherical joint. With the pipe nipple extending downward through the floor the spider is placed over the nipple, its legs bearing against the underside of the floor. The follower is next placed against the spider and the whole fastened together by a large nut threaded to fit the long pipe thread on the nipple.

Three cast-iron washers or pads recessed on the tops are placed between the legs of the spider and the concrete surface to distribute the bearing against the concrete. These washers or pads can be omitted if desired. If the location of the final positions of the valves below the floor can be determined within two or three inches, a tin can tacked to the top surface of the form for concreting the floor, cores an opening sufficiently large for the passing of the nipple fastened to the stand. The extension stem from the valve passes upward through the nipple to the hand wheel of the stand. When the stand is properly centered over the valve, the tightening of the nut fastens the stand securely in place.

To the engineer interested in the construction of power and pumping stations and of small rapid sand filter plants and who has experienced the usual difficulty of properly fastening valve stands to a concrete floor and keeping them so fastened, this type of floor stand will probably appeal. The ease with which it can be centered over the valve; the simplicity of the fastening device; the ball and socket joint which allows the fastening to adjust itself to the irregularities of the concrete surface, and distribute the pressure equally through the three legs of the tripod, are important factors in the design. Floor stands of this type were made for plants on which the writer was engineer and have proven very satisfactory. One of the companies making a specialty of equipment for rapid sand filter plants has used a larger number of floor stands of similar design in their work, but the floor stand described in this article shows important differences in design and method of fastening. It will be seen that this stand can be readily used in connection with wooden floors, in which case the washers or pads for use over the legs of the tripod are required.



Assembly and details of floor stand

LIEUT. C. B. L. ANDERSON, U. S. N.

Portsmouth, Va.

Armature Testing Sets

A reliable and satisfactory test set that can be used in making the bar-to-bar test for faults in armatures is shown in Fig. 1. This set is of the visual type and has some advantages over the outfit shown in Fig. 2. The meter, Fig. 1, is a direct-current switchboard or portable-type ammeter without a shunt, connected to two test leads as indicated in the figure. For the source of power connect two to four dry cells in series to the points *A* and *B* on the commutators. On some armatures it is necessary to move these points closer together than is shown in the diagram in order to get a suitable reading on the ammeter; this can be found only by test. Take the two test terminals and touch adjacent commutator bars; if the coils are all right, the ammeter will read approximately the same on any two adjacent bars. After testing all the bars between *A* and *B*, shift the leads from the battery around the commutator and test again until all the commutator bars have been tested. If a coil or two commutator bars are shorted, the reading on the ammeter will be low. If the coil is open-circuited, there will be no reading on the ammeter until the open is bridged by the test terminals, when the ammeter needle will be thrown violently across the scale. If the leads of a coil are poorly connected to the commutator bars, the reading on the ammeter will be higher than normal. A reverse coil cannot be located by this method. One of the simplest ways of locating a reverse coil is with a compass to determine the polarity of the coils.

The test set shown in Fig. 2 is constructed from a 75-ohm telephone receiver with a head band, connected to two test leads as shown in the figure. Two to four dry cells are connected in series with a buzzer to the points *A* and *B* on the commutator. On some armatures it is necessary to move these points closer together than is shown in the diagram, in order to get a suitable sound in the receiver; this can be found only by test. Take the two test terminals and touch adjacent commutator bars. If the coils are all right,

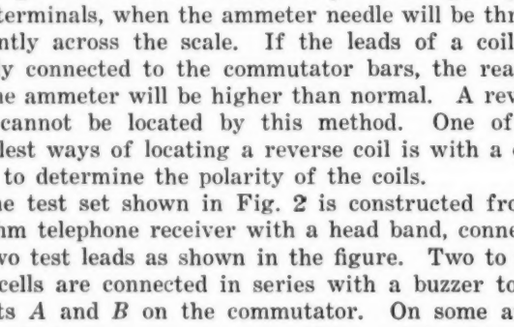


Fig. 1—Connections for testing armature with an ammeter and dry cells

the sound heard in the receiver will be approximately the same on every two adjacent bars. After testing all bars between *A* and *B*, move the current leads around a little and test again until all the bars have been tested.

If a coil or two adjacent bars are short-circuited, the sound in the receiver will be low. If a coil is open-circuited, the sound in the receiver will be very loud when the open is bridged by the test terminals. If a coil's leads are poorly soldered to the commutator bars the sound will be loud, depending upon the resistance in the connection. A little practice will enable anyone to make a thorough test.

I have tested direct-current armatures as large as 300 hp. with four dry cells and a telephone receiver, armatures as large as 200 hp. with four dry cells and the millivoltmeter; that is, a direct-current ammeter without a shunt. As far as I know and from experience

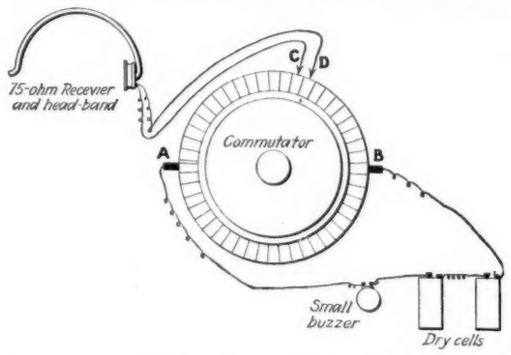


Fig. 2—Connections for testing armature with a telephone receiver and dry cells

any direct-current armature can be tested with two to six dry cells and a telephone receiver or millivoltmeter.

In the figures the points at which the current is led into the armature are set on opposite sides of the commutator. In actual practice this is seldom the case and they are generally located to include approximately one-fourth or less of the commutator bars, and the testing is done between points that take in the least number of bars. The smaller the armature the closer the points will have to be set, as there is considerably more resistance in the small-sized armatures than in the larger sizes. I have tested small armatures and had only about six or eight bars between points *A* and *B*. Either method, telephone receiver or millivoltmeter, is practical and the results are reliable.

Phœnix, Ariz. FRANK HUSKINSON.

More About Water Columns

Although much has been written on the operation and proper method of connecting water columns to the boiler, the subject is not exhausted. A boiler was set up to furnish steam for a laundry. An injector was installed to supply the necessary water. It was admitted that the injector was too large to give a steady feed, but it seemed to fill the boiler altogether too fast. An engineer was asked to suggest a remedy, and he found that steam to operate the injector was taken from the top connection of the water column, consequently the pressure in this pipe was reduced. Of course the water level here was not a true indication of that existing in the boiler. He suggested that steam be taken directly from the boiler, through a connection used for no other purpose.

In another case the water level would rise much slower, but still it was not satisfactory, because it would fall quickly when the injector was shut off. Investigation showed that the feed water was delivered into the lower connection of the water column.

In both of these cases the temptation to save the expense of making a separate connection, brought about a dangerous condition. W. H. WAKEMAN.

New Haven, Conn.

Comments from Readers

Checking Turbine Water Rates

In the July 7 issue there was an editorial on the possibility of checking turbine water rates by means of zone pressure gages. This is not only possible but practical. The pressures in a given stage at various loads can be observed and a curve plotted for reference. Given the steam pressure and quality at the throttle and the vacuum, the manufacturer can then supply the necessary data for plotting a water-rate curve against the zone pressure.

The required data then are throttle pressure, zone pressure, steam quality and vacuum. The instruments for obtaining these should be at hand if not already installed. The results should be as accurate, though of course not so easily obtained, as those supplied by an indicating flow meter.

L. A. PIERSON.

Devon, Conn.

Auxiliary Drive and the Heat Balance

I was interested in the article on "Auxiliary Drive and the Heat Balance," on page 508, of the March 31 issue, which showed the advantages to be derived from the electrification of auxiliaries in an isolated plant. In the July 7 issue, Mr. Kerr takes issue with the conclusions, and presents the case of the small steam turbine.

It seems to me that Mr. Kerr's "twenty years designing and building small steam turbines" has led him to overestimate its fields of usefulness.

In the first place he assumes that in the non-condensing isolated plant under discussion the main units would be turbines. The main units would be more likely to be compound or unaflow engines rather than turbines. Next, he says, "The author contends that heat balance is almost invariably improved by electric drive, assuming that bled steam is available for feedwater heating." This statement in the original article did not apply to the case under discussion, but was simply a statement of what had been clearly demonstrated in a station devoted solely to power generation. In a non-condensing isolated plant bled steam would not be used for feed heating.

Mr. Kerr then figures that the water rate of the main units would be 34 lb. per kw-hr., and shows that the assumptions for steam auxiliary drives give a water rate of 94 lb. per b.hp.-hr. He considers this entirely too high and replaces it with his assumed water rate of 48 lb. for the "modern small turbine."

I'll venture the assertion that the average isolated non-condensing plant having a water rate of 34 lb. per kw.-hr. on its main units *does* use close to 94 lb. of steam for a b.hp.-hr. of auxiliary drive. I question the figure of 48 lb. for even the most modern of the small turbines.

Then he expresses the opinion that the pursuit of the better heat balance has led power-plant designers away from the real objective, which is the "dollar balance," rather than merely a "heat balance." This, of course, has sometimes happened, and we will come back to that later.

Next, he makes a comparison of values which, if correct, must surely convince even the central stations of the folly of using electric auxiliary drives. He starts with coal at $4 a ton and figures 40c. as the cost of making 1,000 lb. of steam, all costs included. Then he assumes the selling value of current at 4c. a kw.-hr., and shows that the power for driving the auxiliary motors is worth 28c., whereas the steam for the turbine drive is worth only about 13 cents.

First, who is buying coal for $4 a ton delivered? Even plants buying the cheapest steam sizes of anthracite usually find that it costs them at least $5 a ton in the bunkers. His unit cost of steam is certainly out of line. Even fairly large isolated plants, using as much as 300 to 400 million pounds of steam per year, usually find their unit steam costs to be in excess of 50c. Further, with a steam cost of only 40c., or even with 50c., current should not cost 4c. per kw.-hr. Such a plant should be able to make current for less than 3c. per kw.-hr. And if the selling value is 4c., this would be the value 10 or 12 miles away from the generating station and would include the cost of distribution, substations or transformers, line losses, etc. The comparison, then, is between the value of steam at its source and the value of current delivered at a point far from its source. The comparison is obviously unfair.

Then, in order to strengthen his small-turbine case further, Mr. Kerr goes into an elaborate discussion of the possible uses for the exhaust from the small turbine. Why look for them when all the main unit exhaust is blowing out into the air?

He fits the plant up with economizers, exhaust steam air preheaters, etc. Imagine what would happen to the "dollar balance" for which he pleads if the average isolated non-condensing plant were decked out with all these frills just to make sure that the exhaust from the auxiliary turbines was used.

Returning to the original article, the question of the relative merits of the electric motor, the small steam turbine, or the steam reciprocating unit is a comparatively simple one. If the plant has use at all times for all the exhaust steam that is turned out, it does not make much difference what type of drive is used. Use that which has the lowest cost and maintenance. Economy of energy in the drive is not a factor.

If exhaust is used for heating purposes during the colder months and blows out the stack the rest of the year, then it is time to give the electric drive serious consideration, for it will usually pay handsome dividends. I have a typical case in mind where a motor-driven centrifugal pump paid for itself every nine months. The steam unit was retained for emergencies.

Mr. Kerr is certainly wrong in holding the small steam turbine as the best auxiliary drive for the average non-condensing isolated plant.

North Glenside, Pa. W. J. RISLEY, JR.

Circuit-Breaker Alarm

In the June 30 issue there appeared a description of a circuit breaker-alarm which, as the writer stated, is not foolproof since a switch is used to open the bell circuit if the breaker is to be left open.

The circuit-breaker alarm illustrated herewith has been installed by the Interborough Rapid Transit Co., New York City, on a number of circuit breakers and it

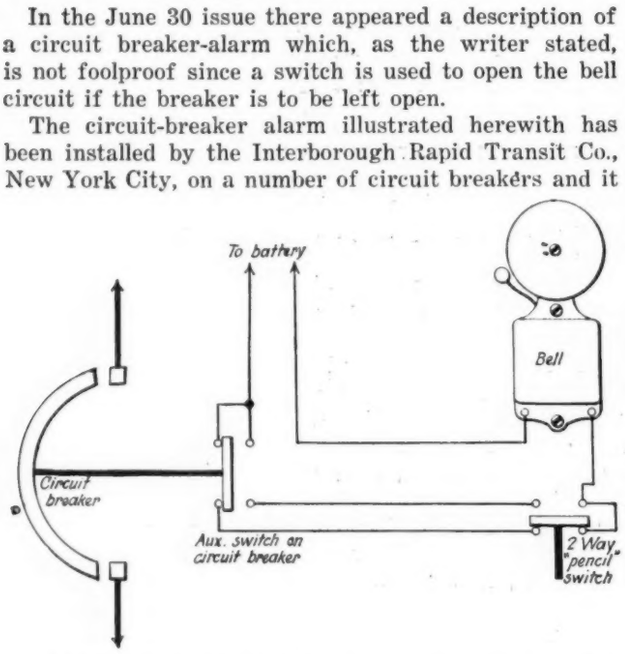


Diagram of circuit-breaker alarm that is foolproof

is foolproof. The usual auxiliary switch with which the breakers are equipped was utilized in connection with a small "pencil" switch, which is a standard product on the market. When the circuit breaker opens the alarm circuit is closed and the bell rings. If the circuit breaker is to remain open, the pencil switch is pushed in, in order to open the bell circuit. If, however, the breaker is closed without previously resetting the pencil switch, the bell rings once more and warns the operator to reset his alarm. The wiring is similar to that used for independent control of a lamp from either of two locations. A. H. BEILER.

New York City.

Producer-Gas Engines

In *Power* of May 5, L. D. Anderson sought information concerning the reliability of gas engines for work in the arid districts of Utah. I have had considerable experience with steam, producer-gas plants and am engaged in an electrical power station containing two horizontal 4-cylinder 500-hp. and one 4-cylinder vertical tandem 250-hp. gas engines. In addition there are two Diesel engines, one 750-hp. and the other 150.

Our traction load is fluctuating continually between 0 and 700 amperes, and the supply load varies from 100 kw. during the night to 900 kw. at the evening peak. I mention these details to show the adverse conditions under which the gas engines operate. With regard to their reliability, I believe that there are some gas engines not worth considering and there are others just as reliable as any steam engine. The 4-cylinder horizontal engines we have installed in this station have been running daily on an average of 136 hours a week ever since they were erected, over five years ago. Never during that time have they once failed us. They require little attention when running, are built on very compact lines, and any trouble is easily and quickly located. Our only worry is preignition due to dirty gas. However, this is easily remedied by using water injection in the cylinders.

In the selection of a prime mover for any given service, one should be governed by the horsepower required as well as other conditions. When over 500 horsepower is needed I do not think a gas-producer engine can show a better economy than a steam or Diesel plant. Here in New Zealand we have many gas plants installed in large freezing works and power stations, and it is generally recognized among those operating them, that steam plants could show better results.

Undoubtedly, a poor quality of coal can be used with success in pressure gas producers. We are using a poor grade of lignite coal with good results. On the other hand, I have never met with a class of coal that could be burned in a producer that could not be burned on a traveling grate under a boiler.

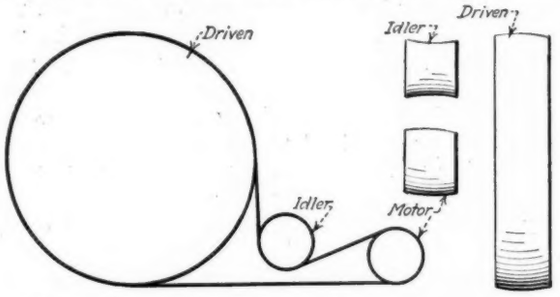
Many small suction gas plants in this country are showing excellent economy in operation. The fuel generally used is coke or a little better class of coal than is required for pressure producers. I can quite understand why gas producing plants are not so popular in America, for they have formidable competitors in the Diesel engine. J. ARCHER.

Napier, New Zealand.

Concaving the Idler Pulley Stops Excessive Wear

The articles on crowned or concaved idler pulleys of the May 12 and June 30 issues were interesting, and I would like to offer a little of my experience.

On an air compressor, a 10-in. double-leather belt had to be discarded on account of its broken condition, the air pockets, etc., after being used only nine months. Upon the suggestion of our belt department the flat-faced idler pulley was concaved to conform exactly with the crown of both the driver and the driven pulley, as shown in the figure. The results have been satisfactory, as this type of belt has been running



Idler pulley surface concaved to conform with belt shape

continuously for the past five months. All equipment is in first-class condition.

The belt, in traveling over the original flat idler, made it necessary for the crowned shape of the belt to be flattened out in width after being shaped to the crown of the driving motor pulley. Then immediately on leaving the idler, the belt was shaped to the crown of the driven pulley, and so on. This continued bending and straightening of the belt in two directions would open air pockets in the center of the belt, causing trouble. ROGER F. WILEY.

Denver, Colo.

Who Should Be the Boss?

In a factory or steam plant of any kind who should have charge of the engine and boiler room, the master mechanic or the engineer? I know of a plant where the master mechanic is chief engineer, chief fireman and in fact boss of the whole works. In the event of trouble in the plant the foreman or engineer must look him up before anything can be done to get things right. For instance, if the engineer went into the boiler room and noticed that the water was low and he ordered the injector started, the fireman would reply, "My boss hasn't told me to," and he would let the water go out of sight if the master mechanic didn't happen to come in and order the injector started.

In my twenty years' experience in power-plant work I have never seen anything to equal this plant. The master mechanic and the firemen are frequently drunk while on duty and they get away with it.

The operating engineer on this job is a steady conscientious fellow and can be depended on, but he is working under a big handicap for he is watched closely, for fear he might draw five minutes overpay. He is not allowed sufficient time to examine the engine or key up, unless he does it on his own time, while the master mechanic and a couple of his pals get in a lot of unnecessary overtime and nothing is said. If there is a repair to make on the engine, the master mechanic takes charge and the engineer has nothing to do with it.

Every plant where I have worked the engineer had charge of the engine and boiler room and if there was a breakdown he stayed on the job and saw the repairs made.

It seems strange to me that the owner of a mill will tolerate such conditions as prevail at this particular plant. The master mechanic was given the job simply because a friend recommended him and he was out of work.

I trust there are not many plants where similar conditions are to be found, but I cite this example as an illustration of what some engineers are up against. In my opinion the engineer should be the boss.

Chicago, Ill. R. S. BUCHANAN.

Power-Plant Instruments

In the July 14 issue Mr. Ramage comments on the necessity for providing means for the occasional checking of power-plant instruments to insure their continued accuracy.

He says in part, "Gas analysis machines, being especially sensitive to misadjustment, should invariably be provided with tee connections in the sample lines so that checking with the hand Orsat may easily be done."

This advice is emphasized by the experience of the Bureau of Mines in a recent comparative test run on four CO_2 recorders of different types. It was found after installation that "for the first few days all the instruments were giving acceptable accuracy." At the end of a sixty-day test only two of the four were operating satisfactorily, although the routine attention recommended by the manufacturers had been carefully followed.

The Bureau found that, in general, the CO_2 instruments on the market give accurate results when all elements are favorable. They concluded that a CO_2 instrument needs more-than-occasional intelligent checking and care.

A case recently came to my attention where a CO_2 recorder was used in a plant for checking the operation of different boilers. A manifold system of piping allowed records to be made on one boiler each day. This record showed low CO_2 and did not check with the charts on the air-flow, steam-flow meters. These meters showed excellent operating conditions.

Checking the CO_2 recorder with a hand Orsat showed that the recorder itself was fairly accurate, but when samples of the gas were taken at the boiler, they showed from 1 to 4 per cent higher than the record. In other words, leaks in the manifold piping system were causing false readings.

Another case showed the importance of occasional checking of the accuracy of a flow meter, not only for meter operation, but for the operation of the integrator.

In this case the operation of the meter itself had been frequently checked and found satisfactory. But the steam sales were billed on the basis of the integrator readings, and when the charts were planimetered, it was found that integrator wheel slippage caused the selling company to lose over $200 a month.

The latest types of flow meters on the market have incorporated much more dependable types of integrators, but there are still thousands of meters in service where the integrator is depended on for the record and where those responsible for the meter have no idea of the accuracy of this device. Occasional planimetering of two or three charts in succession will reveal backsliding tendencies in the accuracy of the integrator. W. J. RISLEY, JR.

North Glenside, Pa.

Engineering and the Man

Every year brings to the commercial doors of the world a crusading army of technical graduates seeking admission. Each holds in his hand a diploma significant of some technical course completed, and many hold in mind a belief of economic independence assured thereby. Unfortunately, among these confident invaders only a comparatively few possess the inherent capability for outstanding success; the remaining ones are the young men of moderate and minor aptitude. Those in the first group, fully capable of carrying through by themselves, incarnate no problem and require no discussion; it is the lesser ones who experience the bitterness of disillusion and attendant discouragement. In common with all of the mathematical sciences, engineering demands minds accurate and exact in detail, and it is not surprising in this period of parental-picked careers, that many excellent business or medical brains have received a misfit education.

The predominating result is a common indictment of the profession by its failures and their friends, who invariably present as authority the law of supply and demand, illustrated by a comparison of the engineer and bricklayer. However, it is a poor comparison, as the bricklayer holds at present an artificial value. Realizing that his skill may be acquired with comparative ease, he has increased his pay by instituting a managed supply, while the engineer, armed with a university diploma and a grain of professional jealousy, invites any man who can, to take his job. Consequently, engineering standing today, in contrast to that of the the bricklayer, is maintained in an atmosphere of constant competition, and the engineer who is displaced by one better is unfair to blame the profession in

general and point to the member of a monopoly as proof of his ill treatment. For the man displaying initiative, judgment and a working knowledge of his profession, there is never a lack of employment; he possesses qualities in perpetual demand.

The letter in the June 23 issue, entitled "A Pessimistic View of the Engineer's Prospects," is a rather bitter indictment of engineering. The author cites as examples three men of varied experience unable to command more than a modest income. The explanation is that not one of these men has succeeded in creating a demand for himself; not one has shown himself above the crowd. The world has placed upon them a nominal valuation, and they have failed to demonstrate any need for increasing it.

Engineering as a career holds great possibilities, but the profession is not paternal and recognition comes only to those who earn it. The discouraging positions of those who have tried and failed cannot honestly be laid to the present order; it isn't the engineering, it's the man.

ROBERT H. EMERICK.

Philadelphia, Pa.

Construction and Use of the Thermocouple

I should like to add a few remarks to what was said on the construction and use of the thermocouple in the article by C. E. Colburn in the June 2 issue.

We have made in the past, and are at present making use of thermocouples, or rather thermoelectric pyrometers, for the measurement of gas temperatures ranging from 500 to 2,500 deg. F. Several types are used, depending on the conditions of service and use made of the data obtained from them. The simpler instruments, particularly those with base-metal couples are cheap, rugged, well made and will withstand considerable rough usage. The finer instruments are of course more delicate and require considerable care and attention, both in the matter of location and maintenance. Owing to inherent characteristics the instrument, even as made by leading manufacturers, is not perfect and requires frequent calibration or checking, although the modern instruments have compensating devices and adjustments to take care of all possible conditions. A fouled couple, a loose or broken lead wire or rough handling may change the calibration of the instrument and give misleading readings.

The thermocouple is in reality a small battery, made by joining two dissimilar metals, and if heated in a closed circuit, an electromotive force or voltage will be produced, its value depending on the temperature difference of the couple and the external circuit containing the cold junction. This emf. is small, being measured in millivolts, either by a potentiometer, or galvanometer. The former is fundamentally a laboratory method, commercial instruments making use of the galvanometer for both the indicating and recording types. From experiment it is found that a certain temperature difference will produce a certain emf. and the scale of the galvanometer is graduated directly in degrees of temperature, so that the needle deflection indicates the temperatures directly, even though the instrument is measuring electromotive force.

Unfortunately, the homogeneity, purity and temperature of the metals enter into the net emf. produced and the reproduction of a couple from specifications is a matter of skilled metallurgy. It being understood, of course, that the emf. from various metals, say platinum-platinum-rhodium couple, is not the same as that from a copper-constantan couple for the same temperature difference. If, however, we assume that the emf. of a certain couple could be calculated accurately, after making from ordinary commercial metals, its measurement would still entail considerable difficulty, outside the laboratory, due to galvanometer and external circuit errors caused by lead resistances and temperature differences. To give reliable results the pyrometer must be calibrated for various temperatures by comparison with a standard, preferably in an electric furnace. If the pyrometer be used without calibrating, merely using calculated data, the instrument will give consistent results, but in a case of this kind constancy should not be confused with accuracy. While the calibration is taking place, the leads and galvanometer are subjected to a room temperature of, say, 70 deg. F., and if the instrument is later taken to the boiler room where the temperature may be 95 deg., a correction must be applied to the observed reading. If we call the standard, or calibration, temperature T_s and the room temperature T_r, this correction will vary from about 0.3 $(T_r - T_s)$ to $(T_r - T_s)$ depending upon the couple used. For base-metal pyrometers the correction factor will be nearly unity, while a rare metal pyrometer of couple correction will be close to 0.5. Various methods of taking care of this cold junction correction have been used, such as mercury bottles, thermos bottles, burying the junction, etc., the most successful being the bi-metal spring, similar to the balance wheel in a watch, which automatically takes care of the correction. The patents on this spring have recently expired and it is now in general use.

The construction of a pyrometer, to give accurate results, is not a hit-and-miss matter, but requires careful design, manufacture and laboratory calibration. It certainly is not a task that one should attempt without previous experience, in the belief that it is a simple, troubleproof cureall for temperature measurements. The pyrometer properly used is a reliable instrument, but for steam-line work with temperatures of 750 to 800 deg. I believe the mercury thermometer or the gas-filled recording type to be much superior. Stem correction on the ordinary thermometer is a simple matter, while the recording instrument can be checked easily by means of a standard. This is especially true in a small plant where expense is an item and time for properly taking care of instruments is at a premium. For the same degree of accuracy the pyrometer will much exceed the mercury thermometer in cost. Neglecting this point, however, and considering the cost of pyrometers, it is evident that at present prices one cannot afford to bother with home-made apparatus even though the accuracy desired could be obtained. Recent approximate quotations show indicating instruments with a maximum scale of 1,000 deg. F., $25, recording instruments with a maximum scale of 850 deg. F., $150, and duplex recording instruments with one scale of 1,000 and the other of 3,000 deg. F., $350. These prices include instruments, thermocouples, leads and protecting tubes which are necessary for high temperatures.

Many other points regarding operation and possible errors, together with much valuable and interesting information, is contained in a bulletin of pyrometric practice by the Bureau of Standards. Anyone interested in the subject will find the publication interesting.

Clarkdale, Ariz. RICHARD H. MORRIS.

Questions and Answers

Conducted by

Franklin Van Winkle

Checking Height of Glass Water Gage

How can the proper height of water glass be checked on a vertical fire-tube boiler? *S. P.*

The lowest visible part of the water gage glass should not be at a lower level than the level for the fusible plug, and the lowest safe water line, and in vertical fire-tube boilers this should be not less than one-third the length of the tubes above the lower tube sheet.

Knock in Duplex Boiler-Feed Pump

What would cause a duplex boiler-feed pump to knock between one-half and three-fourths stroke when running at medium speed? *E. H.*

The valve gears of duplex feed pumps usually are so provided that when one side completes about ⅞ of its stroke, it has opened the steam valve of the other side. The knock may result from a movement of a loose piston on its rod or sudden displacement of a worn piston ring at the time of reversal of the stroke and would be worse from presence of air in the water cylinder causing the pump to jump in the beginning of a stroke.

Soap and Water for Cleaning Cylinders of Air Compressors

How are cylinders of air compressors cleaned with soap and water? *S. B. H.*

Use ordinary soft soap and water or ordinary laundry soap and water of a consistency that will flow as easily as very thin lubricating oil. The solution can be fed into the cylinder by an oil cup one day per week or may be forced into the cylinder by an oil pump. As soap and water is a poor lubricant, it must be used more freely than oil, and then will be found effectual in cleansing the cylinder, ports and valves of carbonaceous and gummy matter. If the compressor is to be shut down, as at the end of a shift, the feeding of soap and water should be discontinued and cylinder oiling should be resumed, to prevent formation of rust.

Removing Scale from Water Jacket

What solution can be used for removing scale from the water jackets of compressors? *E. S. C.*

The scale deposited in water jackets of oil engines, compressors, etc., usually can be softened or dissolved with muriatic acid. It is customary to fill the jackets with a solution of 1 part of muriatic acid and 2 parts water. After standing about twenty minutes the scale will be softened. The acid solution and loosened scale then should be removed by washing out the jacket spaces with clean water, repeating the process if found necessary. The acid solution should not be left in the jacket longer than necessary, as it attacks the metal of the cylinder and jacket and after treatment the jacket should be thoroughly washed out with clean water.

Interchanging Crosshead Shoes

If an engine has babbitted crosshead shoes and bored guides, and the bottom shoe shows the greater amount of wear, is it practicable to place the bottom shoe on the top of the crosshead? *M. J.*

It is practicable to interchange the shoes, provided good bearings can be obtained for both shoes when the shoes are adjusted to obtain the proper height for the crosshead. However, before the adjustments are considered to be final, the shoes should be tried in their new positions and high spots should be scraped to a good fit with the guides. If fitting the shoes would not leave enough leeway for taking up subsequent wear, it would be better to rebabbitt and refit the worn shoe for use in its old place.

Size of Exhaust Main for Several Exhaust Branches

We wish to join the exhaust of several engines and pumps into one or two exhaust lines and for that purpose have on hand a considerable quantity of 10-in. and 12-in. pipe that has been removed from high-pressure service. What rule can be followed for determining the size or number of pipes required? *E. C. B.*

The best practical guide for the minimum sizes for an exhaust pipe of ordinary length is the exhaust size provided by the manufacturer of the pump or engine that is to be connected.

When two or more exhaust pipes are merged into a single main, the sum of cross-sectional areas of the branches will be larger than necessary for the cross-sectional area of the main. For practical purposes make the diameter of the main such that the square root of the fifth power of the diameter will be at least equal to the sum of the square roots of the fifth powers of the diameters of the branches. For instance, if there are four 3-in., three 4-in. and two 6-in. exhaust branches, the sum of the square roots of their fifth powers would be

$$4\sqrt{3^5} + 3\sqrt{4^5} + 2\sqrt{6^5} = 335.7$$

and as $\sqrt{10^5} = 316.2$, one 10-in. main would be sufficient for most practical purposes.

Reducing Discharge Temperature of Ammonia Compressor

Our 60-ton dry compressor machines have a very hot discharge, sometimes as high as 280 deg. F., owing to contracted area of valves and passages leading from valves. If this high temperature is detrimental to ammonia, is there any advantage in reducing the superheat directly as the ammonia leaves the discharge valves, by enclosing the discharge pipe in a jacket, through which water is circulated? *J. B.*

There will be no benefit in jacketing the discharge line of your compressor so far as reducing the work of the compressor is concerned. It is doubtful if con-

tracted discharge-valve areas cause any superheating, although some superheating will take place in the suction-valve passages through heat absorption from the hot cylinder and piston heads. A discharge temperature of 280 deg. F. is not excessive. As may be seen from the accompanying table, that with 10 lb. gage suction pressure and the vapor coming to the compressor at a temperature of 7 deg. F., a discharge pressure of 195 lb. gage will give a discharge temperature of 278 deg. F., even without any cylinder superheating. If the discharge pressure at which your machine operates does not check closely with the discharge pressure for 280 deg. F., some cylinder superheating is taking place.

Suction Pres., Lb. Gage	Suction Temp., Deg. F.	Discharge Pressure, Lb. Gage: 125	135	145	155	165	175	185	195	205
		Discharge Temperature, Deg. F.								
0	26	270	280	290	300	310	320	330	340	350
5	16	240	250	260	270	280	290	300	306	312
10	7	215	225	235	245	255	263	270	278	282
15	0	195	205	215	225	235	245	253	260	265
20	6	180	190	200	210	220	228	235	242	243
25	12	170	180	190	200	205	213	220	229	243
30	17	158	168	177	185	196	202	210	217	223
35	22	150	158	167	176	185	192	200	207	215

It is probable that the suction gas is coming to the compressor with some superheat, which naturally increases the discharge temperature given in the table. The suction temperature should be only a few degrees above that shown opposite the suction pressure in the table. There is no danger from ammonia deterioration, but the oil may carbonize if not of the proper grade.

Over-Rated Performance of Boilers

Our plant has six boilers each with 3,470 sq.ft. of heating surface. In operating five of the boilers for 24 hours and one of the boilers 22 hours, there was 1,753,600 lb. of water evaporated into steam at 150 lb. gage pressure, from feed water at the temperature of 210 deg. F. At what percentage over-rating were the boilers operated? *J. M.*

Assuming that the output was dry saturated steam, at the pressure of 150 lb. gage or 150 + 15 = 165 lb. per sq.in. absolute, as shown by the steam table, each pound of steam contained 1,195 B.t.u. above 32 deg. F., and with feed water at the temperature of 210 deg. F., each pound of feed water contained 178 B.t.u. above 32 deg. F. Therefore each pound of feed water for generation into steam received 1,195 — 178 = 1,017 B.t.u.; and as for evaporation from and at 212 deg. F. each pound of water must receive the latent heat of evaporation, or 970.4 B.t.u., the factor of evaporation was 1,017 ÷ 970.4 = 1.048.

As five of the boilers were in operation 24 hours and one boiler was in operation 22 hours, the number of square feet of boiler surface in operation was 3,470 × 5 = 17,350 sq.ft. for 24 hours, and 3,470 × 1 = 3,470 sq.ft. for 22 hours, which would be equivalent to (17,350 × 24) + (3,470 × 22) = 492,740 sq.ft. one hour. Hence the actual evaporation was 1,753,600 ÷ 492,740 = 3.559 lb. of water per square foot of heating surface per hour, and as the factor of evaporation was 1.048, the average equivalent evaporation from and at 212 deg. F. per sq.ft. per hour was 3.559 × 1.048 = 3.7298 lb. from and at 212 deg. F.

The standard for boiler rating is equivalent to evaporation of 3.45 lb. of water from and at 212 deg. F. per square foot of heating surface per hour and therefore the performance was (3.7298 × 100) ÷ 3.45 = 108.1 per cent of rating, or 8.1 per cent above standard rating.

Setting Eccentric for Given Lap and Lead

Knowing the lap and lead for a D slide valve, how can the angular position for the eccentric be determined? *W. L. R.*

Referring to the sketch, place the crank in position of dead center, remove the eccentric strap and, under the eccentric, fix a straight-edge *SS* with parallel edges parallel to the center line of the engine. With a square *QQ*, the blade of the square touching the shaft and back of the square held to the straight-edge, mark points *A* and *B* on the straight-edge so the distance *AB* will be equal to the diameter of the shaft and, midway between these points, locate a mark *C* to represent the center of the shaft.

If no reversing rocker is used, then on the straight-edge, from *C* toward *B*, locate a point *d* so that the distance *Cd* equals the lap plus the lead that is to be

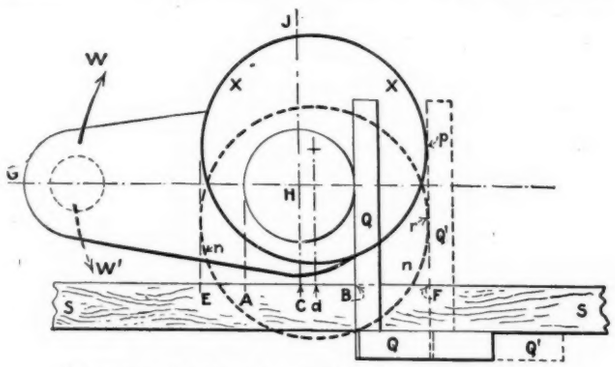


Diagram illustrating method of determining angular position for eccentric

given to the valve. If a direct rocker is used, make *Cd* equal to the sum of lap and lead multiplied by the length of rocker arm operated by the eccentric rod and divided by the length of rocker connected to the valve-rod pin. From *d* as a center set off *dE* and *dF* each equal to one-half of the diameter of the eccentric sheave. Then *EF* is equal to the full diameter of the eccentric and with the square set to the dotted position *Q'Q'*, with the blade of the square at the point *F* and for rotation of the engine in direction of the arrow *W*, move the eccentric around on the shaft to the position *XX* until it touches the blade of the square as at *p*. If rotation of the engine is to be in the direction of the dotted arrow *W'*, the straight-edge *XX* must be fixed far enough from the shaft for the eccentric to be moved to the dotted position *nn* until it touches the blade of the square as at *r*.

If a reversing rocker is used, the point *d* representing the center of the eccentric is to be placed on the crank side of the center point *C* and at a distance from *C* equal to the sum of the lap and lead multiplied by the length of rocker arm operated by the eccentric and divided by the length of rocker arm connected to the valve rod pin. The high side of the eccentric then would be placed at an angle less than 90 deg. behind the crank; that is, for rotation of the engine in the direction of the arrow *W* the high side of the eccentric would be within the quadrant *GHC;* and for rotation in the direction *W'* the high side of the eccentric would be placed within the quadrant *GHJ*.

[Correspondents should sign their communications with full names and post office addresses.—Editor.]

High Spots in the Feed-Water Report

Much of Practical Value Brought Out in Serial Report of Prime Movers Committee

MUCH of interest to the operating engineer is contained in the serial report, "Treatment of Feed Water," issued in July, 1925, by the Prime Movers Committee of the National Electric Light Association. Without making any attempt at completeness, the following paragraphs will bring out certain points of special interest.

Acid Treatment at Calumet

The Commonwealth Edison Co. submitted a statement on the use of acid at its Calumet Station to keep down the causticity resulting from the zeolite process of treating makeup water. By a special arrangement very dilute sulphuric acid was fed to the water. This acid converted to sodium sulphate the sodium bicarbonate resulting from the zeolite treatment. There have been no particular difficulties in the control of this acid feeding system. To avoid the danger of free acid care was taken not to attempt complete neutralization.

Tri-Sodium Phosphate for High-Pressure Boilers

Interesting experiments with the use of tri-sodium phosphate as a substitute for sodium carbonate in its Springdale Station were reported by the West Penn Power Co. Although the greater part of the station makeup was supplied by evaporators, trouble was experienced with scale formation due to condenser leakage. During this time sodium carbonate was being added to the feed water. Since at room temperatures the calcium existing in combination with sulphate in the raw water could nearly all be precipitated by adding enough sodium carbonate to cause the total alkalinity to be greater than the hardness, the company chemists had supposed that the same thing would hold true in the boiler, and that with the alkalinity greater than the hardness all the calcium would be precipitated as calcium carbonate. This did not work out in practice, for reasons that were not understood until attention was called to the recent work of R. E. Hall and others who have investigated water in the boiler from the viewpoint of physical chemistry.

The trouble was due, in brief, to the breaking down of sodium carbonate into sodium hydroxide at boiler temperatures. This breaking down was so rapid that it was impossible to maintain the desired carbonate-ion concentration without increasing the hydroxide concentration to an undesirable value. In April, 1924, after consultation with Dr. Hall, at the Bureau of Mines, the operators of the Springdale Station started using tri-sodium phosphate as a substitute for the sodium carbonate. Since the phosphate radical cannot break up as the carbonate radical does, no trouble is experienced in maintaining the desired concentration. When treating with tri-sodium phosphate the calcium is precipitated as calcium phosphate, and the sulphate combines with the sodium, as when sodium carbonate is used for treatment.

Since this treatment was started only four tubes have failed, these failures being due to cutting by soot blowers. No adherent scale has been formed.

The result is said to support the conclusions of Hall, Fischer and Smith, that adherent scale will not be formed in boilers if the formation of calcium sulphate scale can be prevented. It remains for experience to tell whether deconcentrators will be required to prevent trouble from the large amount of precipitated calcium carbonate or phosphate.

Zeolite Softeners

As a preface to some comparative figures on the cost of softening Schuylkill River water (Philadelphia) in various ways, F. B. Applebaum, assistant technical manager of the Permutit Co., wrote, in part, as follows:

"An endeavor is made to correct a misconception that arises from time to time, namely, that lime pretreatment before zeolite is always to be preferred, irrespective of the water composition. Those who favor such lime pretreatment forget that calcium carbonate has a definite solubility and that, therefore, as the amount of the carbonate hardness of the raw water approaches this solubility limit, there is less and less value and economy in such pretreatment. The experience of the Permutit Company has shown that the lime pretreatment ahead of zeolite begins to show signs of economy only when the carbonate hardness is more than 15 to 20 grains per gallon or about 250 to 350 parts per million expressed as $CaCO_3$, and when such carbonate hardness constitutes the greater part of the total hardness.

"An endeavor is also made herein to correct another mistaken idea, namely, that as the hardness of the raw-water supply decreases, the results which can be obtained by lime-soda treatment improve appreciably. This is not in accordance with the facts."

"Since the first cost and operating costs of a zeolite plant decrease with the hardness, a line is reached where a zeolite plant will produce a water of zero hardness for less cost than a hot-lime-soda plant will produce a 2- or 3-grain water.

Conclusions from Bureau of Mines Co-operative Investigation

R. E. Hall, physical chemist of the Pittsburgh Experimental Station, Bureau of Mines listed the following main developments of the investigation, in co-operation with the Hagan Corporation, into the mechanism of scale formation and boiler-water conditioning:

The adherent scales developed on feed lines and the surfaces of drums and tubes are formed in situ, and never exist as small independent and unattached crystals in the boiler water, subject to motion with its flow. One exception is pieces of broken scale of a size sufficient to resist the flow, which are cemented where they lodge by these same crystallization processes which produced the original scale.

The concentration of treating chemical, necessary in the boiler water undergoing evaporation to prevent hard adherent scale formation, depends on the operating pressure and the sulphate concentration in the boiler water. The chemical may be introduced into the feed or boiler water as desired, so long as appropriate concentrations are maintained in the boiler water.

The use of soda ash as a treating chemical is satisfactory and economical if the operating pressure of the boiler is not too high. But the rate of decomposition of carbonate with formation of caustic, and the carbonate concentration necessary to prevent scale deposition, both increase with increase in operating pressure, so that prevention of scale formation by the use of soda ash becomes impossible at high pressures. The upper limit for the use of soda ash lies not above 250 lb. gage, and its use above 200 lb. is largely dependent upon a well-controlled sulphate concentration in the boiler water. Above such pressures the use of sodium phosphate is satisfactory.

The ratios of carbonate to sulphate concentration necessary to prevent hard adherent scale formation on the evaporation surfaces have been determined for various operating pressures and sulphate concentrations, and have been developed into curves suitable for boiler-room use. Satisfactory ratios of phosphate to sulphate concentration are being investigated at this time.

Simple equipment has been developed for the determination of such concentrations with dispatch and suitable precision by the boiler operator.

The validity of the carbonate-sulphate concentration relations developed has been established by practical tests.

Under this type of control, a thin carbonate scale of practically uniform composition, whatever the character of the feed water, forms on the evaporating and drum surfaces, unless the percentage of makeup water is very small. Its obstruction to heat exchange is small, because of its porosity, and because it does not increase in thickness with continued operation of the boiler.

The percentage of moisture in steam leaving the boiler is believed to be a function of the thickness of the bursting bubble layer in the steam drum, which in turn is dependent upon the concentration of soluble salts in the boiler water regardless of their specific composition, and the specific character and concentration of the suspended solids.

The caustic developed in the boiler water by the decomposition of soda ash is effective in repressing hydrogen-ion concentration in the boiler water and, thereby, corrosion of the boiler metal. The caustic must not be excessive in

concentration, since the dangers of embrittlement are encountered especially if the concentration of other soluble salts is low; but it should be present in well-controlled concentration in every boiler water because of its influence on corrosion.

Urges Uniform Method of Reporting Water Analyses

A communication from J. D. Yoder, of the Cochrane Corporation, discussed the feasibility of a standard method of reporting water analyses.

Water analyses may be reported in the uncombined form, that is, by showing the quantity of metals and acid radicals as determined by the chemists, or the substances may be hypothetically combined in a variety of ways. It is impossible, or at least impractical, to report the analyses with strict accuracy as to the manner in which the metals are combined with the acid radicals in the sample of water analyzed.

As water analysis is a highly specialized branch in which the average engineer cannot hope to become proficient, no attempt will be made to abstract Mr. Yoder's remarks, except to say that he offered for consideration four possible methods of reporting a combined analysis, and recommended two of them as being better suited than the others for boiler-feed purposes.

A statement relative to the purity of products of evaporators as influenced by operating conditions was submitted by the Griscom-Russell Co. They presented two curves showing the relation of purity of vapor to evaporator output for a given type of evaporator.

In discussing methods for controlling the treatment of boiler feed water, Cyrus Wm. Rice & Co., consulting chemical engineers, stressed the importance of simplicity and reliability, in view of the fact that most operating men are not chemists. As the most simple and accurate method of controlling the chemical conditioning of the feed water they recommended the testing of the blowdown water for calcium (scaling salts) in solutions, and a second test of the same order for measuring the quantity of free soda that is required to remove all the calcium from the concentrated boiler water.

The quickest and simplest method of detecting conditions that may cause priming or foaming, according to the statement, is a silver nitrate test for sodium chloride.

Divergent Views on "Caustic Embrittlement"

The Babcock & Wilcox Co. made the following statement in regard to caustic embrittlement:

"The amount of sodium carbonate which can be safely carried in a boiler is not a matter on which anyone can make a definite answer. All we can do is to give our customers the result of our experience and best judgment in the matter.

"Up to date we know of no cases of caustic embrittlement where the sodium carbonate has not exceeded the quantity of sodium sulphate. As a result of this fact we have assumed a working rule as follows: On steam pressures up to 150 lb. the sodium hydrate (expressed as sodium carbonate) plus sodium carbonate should not exceed the quantity of sodium sulphate. On steam pressures of 150 to 250 lb. the sodium carbonate equivalent should not exceed one-half the sodium sulphate. On steam pressures above 250 lb. the ratio should not exceed one third."

The Permutit Company took issue with the theory "that sodium hydroxide formed in the boiler salines from sodium carbonate, may, by some corrosive action, accelerate the formation of cracks in internally stressed material of riveted seams in the absence of sulphates." Commenting on this, they said, in part. "This theory has been advanced because cracks have been found in or near riveted seams of a small number of steam boilers fed with artesian-well waters, high in sodium carbonate and low in sulphates, and also in some boilers fed with distilled water to which large amounts of soda ash have been added. It is proposed by those advancing this theory to maintain a ratio of sodium sulphate to sodium hydroxide in the boiler saline that is greater than one, and hoped that it may be beneficial to internally stressed material.

"It has not been proved that sodium hydroxide accelerates the formation of cracks in internally stressed material. therefore it was impossible to prove that sodium sulphate will inhibit such action. Water supplies of every description have been softened by the Permutit process and have then been used for boiler feed purposes for more than 14 years. We have kept in close touch with all boiler plants using our system, and in many of them the sulphate hydroxide ratio is less than one. Neither we nor the adherents to the ratio theory know of a single case where cracks have been found in boilers fed with Permutized water."

The statement then went on to describe other forms of cracks around rivet holes, lap seams, etc., due to abuses in manufacture and operation.

Hot Process for Overloaded Boilers

The Cochrane Corporation stated its belief that the hot-process water softener was the best adapted for the treatment of feed water for highly overloaded boiler plants. "Its efficiency," they said, "has been well demonstrated by usage, and it is generally well adapted to the power-plant design. It has been extensively used for treatment of feed water of 100 per cent makeup. as with jet condensers, as well as for small percentages of makeup for surface condensing plants."

In connection with deaërating systems mention was made by the Bethlehem Shipbuilding Corporation of the development of a complete closed-circuit feed-water system with automatic controls. Absorption of air is avoided by heating the deaërated water at a pressure above atmospheric after it leaves the condenser.

According to the Griscom-Russell Co. the inclusion of distilled makeup plants has approached nearly 100 per cent for the large central stations, but the greatest increase has been noticed in medium-sized central stations and in industrial plants.

A Decision on Electric Service Rates

By A. L. H. Street

An industrial establishment receiving electric service for both power and lighting purposes is not entitled to evade liability for the higher rate applying to current used for lighting by receiving the current at power voltage and reducing it to availability for illumination, declared the Pennsylvania Supreme Court in the recent case of Westerhoff Brothers Company vs. Borough of Ephrata, 128 Atlantic Reporter, 656. The court said:

"Where the cost of product supplied is uniform, the [public service] corporation selling it cannot object to the use made of it by the consumers. . . . If, however, some consideration for the difference in charge can be made apparent, . . . or if it can be shown there is a difference in the cost of supplying, or in keeping ready to do so, the contrary conclusion is reached. Reasonable distinctions may be made, based on the kind of service demanded. . . . For instance, it may rest on the amount of power consumed and paid for. . . .

"As was recently said by this court in Duquesne Light Co. v. Pub. Ser. Com., 273 Pa. 287, 117 A. 63, 65:

"'While the Public Service Company Law . . . in no uncertain terms forbids rates which are unjust or unreasonable or inadequate, or are unjustly discriminatory or unduly or unreasonably preferential, it nevertheless permits such classifications thereof as do not offend against the provision quoted, and hence a utility company has a right . . . to divide its customers into groups, according to the purpose for which the electricity or steam is needed, these being subdivided into classes according to the quantity taken. . . . '"

The court concluded that a higher rate for lighting purposes was justified by the cost of maintaining the generating plant for lighting purposes during certain hours of the day. The opinion says:

"If anything is to be gathered from the record, it is that the classification made was reasonable, and the difference in charges for power and light based on the cost of production. Complainant, by the ordinance, was bound to pay for the latter service at the same rate as were all other consumers, and it could not evade its responsibility by a subterfuge, reducing the power voltage to that available for illumination."

Tax for Hydro Development in Porto Rico Proposed

A law has been passed by both houses of the Porto Rico legislature levying a tax of one-tenth of 1 per cent on all real property in the island for a period of three years, in order to provide a fund, which it is estimated will approximate $500,000, for the development of hydro-electric power. This has not, as yet, been signed by the governor, but it is thought that he will approve the bill.—*Commerce Reports.*

The Sesqui-Centennial Philadelphia

150 Years of American Independence

By I. S. Proper
Editorial Staff, *Power*

STARTING off in 1921 with brilliant prospects, endorsed by the President, the United States Congress, the Commonwealth of Pennsylvania, the enthusiastic co-operation of the engineering and industrial interests of the country, and with elaborate plans worked out by The Engineers' Club of Philadelphia, the Sesquicentennial International Exposition met with reverses of such diverse and unexpected character, seemingly insurmountable, that for the last two years it has appeared almost impossible that any kind of an exposition could be held.

However, the famous old American fighting spirit at last manifested itself in Philadelphia, the home of so many sacred symbols of this country's ideals, and now most Philadelphians and the press throughout the country generally hold high expectations for the success of the coming celebration, which is definitely scheduled to be held from June 1 to December 1, 1926, "come what may," according to Mayor Kendricks.

The Sesqui, as it is called by everyone, will not be on as large a scale as was originally planned, nor will it have such an extensive foreign participation as was hoped for; nevertheless, as has been shown during the last two months, the exposition will be a dignified and worth-while celebration of the one hundred and fiftieth anniversary of the signing of the Declaration of Independence. It probably will not cover the progress made in mechanical and industrial lines during the last fifty years, as did the Centennial the period between 1776 and 1876, but as the Nation's progress along these lines has been so tremendous and diversified since 1876, it would take an exceedingly large exposition to cover the entire field adequately and certainly would take more time to arrange it than is available.

The site finally chosen for the exposition is on a large, city-owned plot at the foot of Broad Street about a twenty-minute ride from the City Hall, the hub of Philadelphia. The ground has had to be reclaimed in part from the Delaware River, which from time to time overflows parts of it. The League Island Navy Yard, is at the extreme end of Broad Street and will form the southern boundary and also a part of the exposition, or so the Sesqui officials believe. League Island Park is on the west side of the exposition grounds, as may be seen in the accompanying map, and is at present an attractive park although of recent laying out. The stadium is well under way and will provide many attractions for the visitors. The Administration Building is also now in course of construction. The steel framework has been erected, the roof placed in position and the floors laid. The work started on July 21, and under the contract should be finished ninety days from that date. The building will house the offices of the Sesqui officials and personnel.

The Director Is Thrifty

There has been some chuckling in Philadelphia over the cleverness of the Sesqui director, Colonel Collier, in taking advantage of all activities and operations connected with the city that can be utilized for the exposition. He is taking the material that is being excavated from the city's new subway for filling in the Sesqui site. At the present time there are two continuous lines of busy trucks going and coming on Broad Street carrying or returning from delivering the dirt and stones from the subway to the exposition grounds. Most of the filling in near Broad Street has been accomplished. The pools and water features are to be made in the places having the deepest depressions and again Colonel Collier is going to utilize the boards that have been in use over the subway for holding the reclaimed land in place along the edges of these pools and canals. There is a general air to the ordinary observer, of things being accomplished and of smooth running at the site.

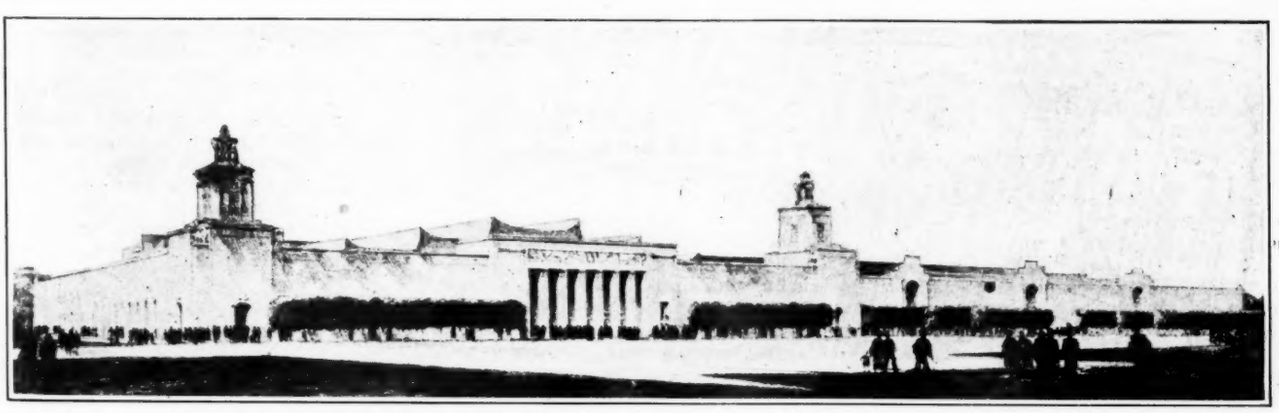
The contract for the first or liberal arts exhibition building was let on Aug. 20, to the Austin Company, Cleveland, a firm having a reputation for speedy construction on large operations, and as it has recently put up a building in the adjoining Navy Yard it is familiar with the ground conditions to be met. This structure will contain about 375,000 sq.ft. of display space and calls for a steel building with a foundation of wooden piles, steel roof trusses supported on steel columns with stucco-surfaced exterior walls. It is stipulated in the contract that filling in and piling must be done in forty-five days, which allows seventy-five days for the construction of the building.

Large Machines To Be Shown in Operation

The machinery building will be the last built, as it has to have special foundations to provide for the heavy machinery, much of which is to be shown in operation. The location of this building, as will be seen by consulting the plan, will be adjoining the League Island Park.

The Sesqui authorities say that more than 2,000,000 sq.ft. of space has already been reserved for exhibitors, who will pay for the privileges granted a sum well over ten million dollars. The United States government, the Commonwealth of Pennsylvania and the City of Philadelphia have all contributed substantial amounts of money so that, it is stated, there will be ample funds to fill in the grounds that are below grade and to build the exposition buildings.

The list of exhibitors who have already reserved space contains numerous firms in the power-plant field. Power will be generated by some of these



Drawing of the Liberal Arts Building for the Sesquicentennial International Exposition

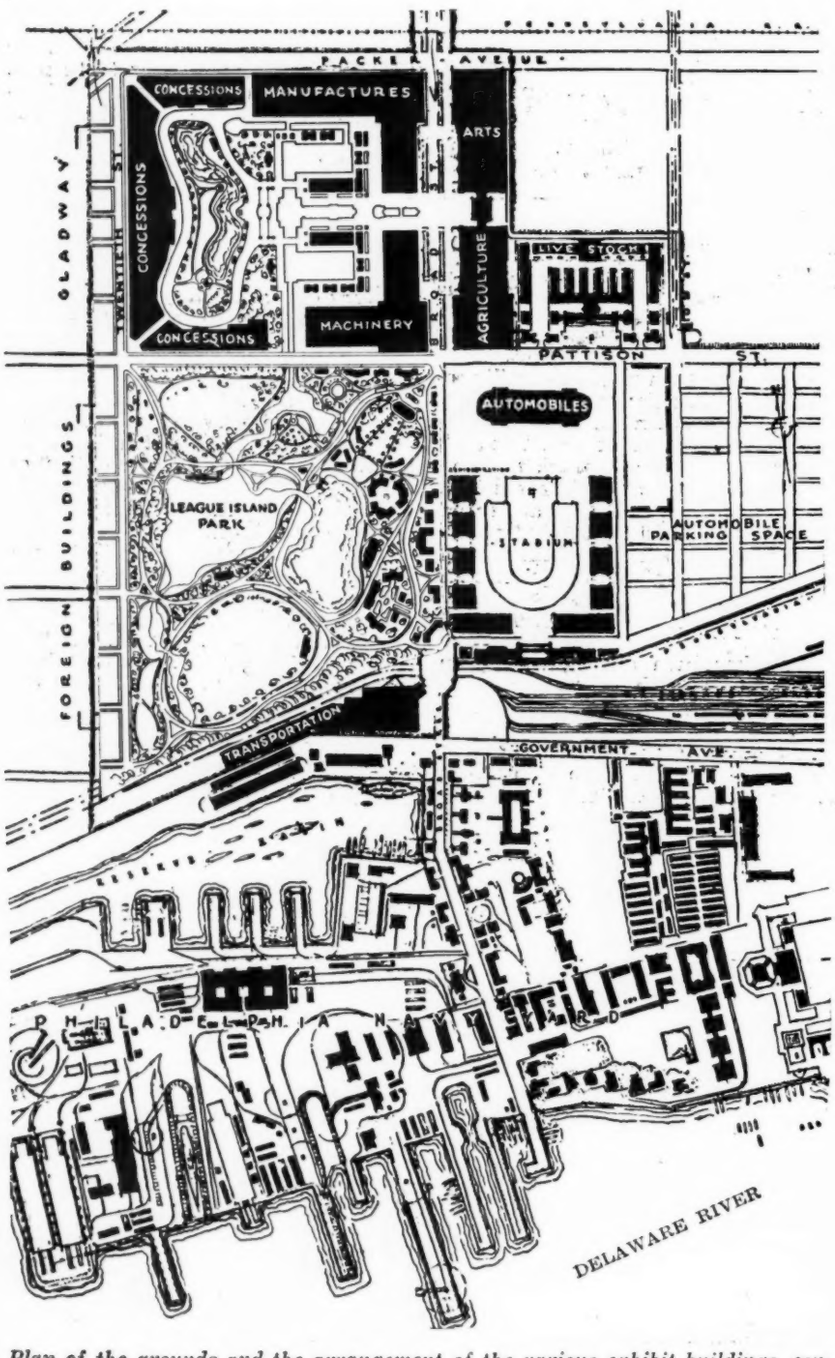
Contract for the erection of this building was awarded during the latter part of August and calls for its completion in seventy-five days. The building will contain about 375,000 ft. of floor space. The machinery building and other exhibit buildings will be similar in style and construction. Contracts for their erection will be let in a very short time, it is stated.

firms for use by the other exhibitors at a cost of 4 cents per kw.-hr. So far arrangements have been made, according to Mr. Meisenhelter, chief of exhibits, for five Diesel engines direct-connected to generator sets to supply 7,000 hp. Four of these engines will be of 1,000 hp., one of 1,500 hp. and two of 500 hp. each. There will be a number of firms showing turbines, one of which will be shown in operation. Three manufacturers of unaflow steam engines have reserved space and will exhibit.

An electrically driven air compressor with capacity of 100 cu.ft. of air displacement will be installed in the machinery building by the Chicago Pneumatic Tool Co., in addition to its large exhibition. It will be attached to a 200-hp. motor and operated continuously during the exposition to furnish compressed air to exhibitors.

While some attention will be given to showing the old models of machines, it is not expected, at least at present, that machine development will be a feature of the exposition.

The floor plan for the machinery building has just been issued but arrived too late for inclusion in this article. The power-plant machinery will be placed in the main part of the building fronting on Broad St. and Pattison Ave. Groups *A* and *B* will be devoted to exhibits of machine tools; group *C* will contain the steam turbines and engines, hoisting engines and steam stationary boilers; group *D* will contain oils, lubrication and fuel, stokers and grates; group *E* will be devoted to the internal-combustion engines, Diesel-engine generator sets and air compressors; group *F* will be given over to refrigerating machines, insulation and kindred subjects; group *G* will, besides other machines, contain the power transmitting appliances; group *I* will have the feed-water purifiers; group *J* the accumulators, pumping and oth r hydraulic machinery; group *K* will contain the exhibits of traveling electric cranes, electrical machinery and electrical recording instruments; group *L* will have the wire products and testing machinery, measuring and recording instruments, fans and pressure blowers; group *M* will be set aside for power and hand conveyors; group *O* will be devoted to coal and oil products; group *Q* will contain the coal and coal-mining exhibits; group *R* will, besides other exhibits, have the brick and clay products.



Plan of the grounds and the arrangement of the various exhibit buildings, concessions, foreign buildings and gladway of the Sesquicentennial International Exposition, which is to be held in Philadelphia, Pa., June-December, 1926

Pageants and Historical Celebrations Outside Sesqui Grounds

The exposition authorities announce that the historical side of the exhibition will be centered at Independence Hall, where was read the Declaration of Independence and from whose towers clanged forth the Liberty Bell. Congress Hall, where met the first Congress of the nation and which adjoins Independence Hall, will also be a center of the celebration, as will the Betsy Ross House, where the stars and stripes were born, historic Carpenter's Hall, where gathered the men who were to create the new republic, the house of William Penn, the grave of Benjamin Franklin and the hundred other spots hallowed by the birth of the American Nation.

The new art museum will have, besides collections which have been bequeathed to it, exhibitions of art loaned by other cities; Fairmount Park will be the scene of interesting pageants, as will also the Delaware and Schuykill Rivers.

Many Foreign Governments Have Arranged to Exhibit

About twenty-five foreign governments have signified their intention to participate in the celebration and the greater number of the states are already lined up for co-operation. The New Jersey building is to be a replica of the British Barracks at Trenton, captured by Washington's troops on Dec. 25, 1776. Many of the exhibits from Wembley, England, as well as from the Paris Exposition of Decorative Arts, are to be brought over. A movement is on foot in Vermont to erect as Vermont's representation to the Sesqui, a reproduction of the Plymouth home of President Coolidge. Porto Rico has signified her intention to exhibit her island industries. It is reported from Maine that the Longfellow Society is arranging to bring the poet's birthplace intact from Portland to Philadelphia for exhibition.

From the back channel of the Navy

Yard will be resurrected and restored to its former fighting trim, the "Olympia" the flagship of Admiral Dewey. This will be a part of the United States naval exhibit.

Twenty-five societies have planned to hold their 1926 meetings at Philadelphia during the Sesqui celebration; among them are the American Chemical Society, the American Society of Civil Engineers, and the Shriners, who have already started operation on a huge replica of King Solomon's Temple which will be on the concession grounds.

Airplane view of Sesquicentennial International Exposition site taken August 15. To the right is the military reservation and at the extreme left the aviation field.

Whaley Constant-Pressure Oil Engine Finished

The Sun Shipbuilding & Dry Dock Co., of Chester, Pa., has completed its contract of building for the Whaley Engine Patents, Inc., the new Whaley oil engine, which was invented by W. B. Smith Whaley. This engine has been shown to stockholders and interested engineers.

This Whaley engine is a single-acting four-cylinder unit operating on the two-stroke cycle and is designed to develop 750 horsepower. It is vertical reversing engine with a scantling frame similar to that of a marine steam engine, and is unusual by the fact that the cylinder clearance, at the time of the fuel injection, is in communication with a large air receiver having many times the capacity of the cylinder clearance.

The Whaley engine employs port scavenging supplemented by high-pressure scavenging and supercharging through the top of the cylinders at a pressure of about 45 lb. per sq.in. The air pumps for the superscavenging and supercharging operation are contained in the lower part of the power cylinders. There is a supplemental scavenging air-pump formed in the upper part of the frame in which operates a piston placed on top of the crosshead. Two cylinders are cast in block with a valve chest between. The air from the pumps just described is used either in direct line or is transferred through the ports in the valve chest to the opposite cylinder.

Under normal running conditions, the builder claims, that, due to the receiver clearance, no variation in pressure is expected no matter what the conditions of loading and fuel injection may be. The receiver serves as an absorber in case of any rise in pressure in the cylinder through any cause whatever. By an ingenious arrangement of the valves, the compression-space port is made to serve successively for the introduction of the superscavening and supercharging and to establish communication with the reservoir or receiver during the combustion period. It is expected that the Whaley engine will weigh less than 100 lb. per horsepower, a figure that represents a substantial improvement over current practice. The Whaley engine plant is being prepared to undergo its shop tests, and the results of performance together with a complete revelation as to machine details will be presented before the winter meetings of the national engineering societies.

Chelan, Washington Project — The Chelan Electric Co., of Seattle, has applied for a license covering a project on Chelan River and Chelan Lake, in Washington. It is proposed to construct a diversion and control dam in Chelan River, thereby giving Chelan Lake a reservoir capacity of 649,000 acre-feet. The project provides for two pipe lines with a diameter of 13 ft. two miles long; five steel penstocks 10 ft. in diameter and 1,000 ft. long; a power house with five generator units. The primary power which thus will be made available is estimated at 65,000 hp. The secondary power will amount to 60,000 hp. The five turbines, however, will be capable of developing an aggregate of 125,000 hp.

National Association of Stationary Engineers Hold Successful Meeting at St. Paul

Educational Activities of Association Principal Theme of Convention

FROM Aug. 31 to Sept. 4 the National Association of Stationary Engineers held its forty-third annual convention at St. Paul, with headquarters at the Hotel St. Paul. The Mechanical Exposition, as well as the business and technical sessions of the convention, were held in the municipal auditorium, two blocks distant. With approximately 375 accredited delegates augmented by a large attendance of visiting engineers, the convention was a decided success. There was a sprinkling of technical papers, and a great deal of time was given to the consideration of a national educational program involving an expenditure of $11,000 which will be similar to the merit system that is already functioning in the State of Michigan.

At the exhibition 152 exhibitors occupying 211 booths gave an excellent display of power-plant equipment, comparing favorably with those of previous conventions. Entertainment of a pleasing character was provided throughout the convention.

Registration and the official opening of the Mechanical Exposition occupied the first day of the convention. On Tuesday the entire delegation, escorted by a band, marched from the headquarters hotel to the auditorium, where they received a royal welcome from J. H. Hay, deputy commissioner, Department of Agriculture, representing the Governor of the state; Arthur Nelson, Mayor of the City of St. Paul; Asa Briggs, president of the St. Paul Association of Public and Business Affairs, and L. R. Ferguson, commissioner of education. In consecutive order responses were made by National President Dudley G. Kimball, National Vice-President Garrett Burgess and Past National President Royal H. Holbrook.

Business began at the afternoon session with reports of Secretary Raven and Treasurer Forse, showing favorable financial conditions and a membership of approximately 20,000. In his report President Kimball urged the state deputies to make a special study of the weak associations in their territory with a view to strengthening them.

He recommended the abolishment of the membership committee and the turning over of the funds to the national deputy. The work of the educational committee had been highly gratifying. The question and answer book in particular was a masterpiece, and it was his suggestion that the questions and answers of 1924 and 1925 be published in a similar manner. His slogan for 1926 would be 30,000 members, giving to the official magazine a corresponding circulation and automatically eliminating the question of advertising mediums that had been raised during the year. As a detriment to the association and the advertising section of the paper he was averse to the use of the name of the organization in connection with the several power shows in various parts of the country.

Garrett Burgess, national vice-president and national deputy, enlarged upon the importance of the state deputies and their work. Leadership was a crying need in the association. Benefit would result from exchange of ideas among deputies. Employers should be informed of what the association can do for them and their engineers. During the year sixteen new associations had been formed, with a net gain in total membership of 273.

The report of the Power-Plant Cost Committee presented by Egbert Douglas, had been printed, giving samples of costs and how they were arrived at, pointing out some of the fallacies about costs, picturing the necessity of keeping costs to show what the plant is doing and accompanied by typical cost forms as used by some of the representative institutions of the country.

The Technical Papers Committee, headed by D. L. Fagnan, had come to the conclusion that the educational work should be carried on for the most part in the local associations and be curtailed in the annual convention. Not to be devoid entirely of technical discussion, two papers had been provided and a public evening session devoted to motion pictures and lecture by C. E. Skinner, assistant director of engineering of the Westinghouse Electric & Manufacturing Co. The subjects covered were: "The Electrical Industry in the Early Nineties"; "The Westinghouse Works in Operation"; "An Electrified Travelogue," and "White Coal," the last-named reel bringing out the latest developments in the hydro-electric field.

Of the papers mentioned, F. L. Hansen, of the Ideal Electric & Manufacturing Co., reviewed the "Evolution of the Synchronous Machine." An abstract of this paper will appear in an early issue of *Power*. "The Uses of Copper and Brass in the Power Plant" was the topic of the second paper, which was presented by W. G. Schneider, research engineer of the Copper and Brass Research Association.

An outstanding feature of the convention was the report of the national educational committee and the ensuing discussion of the proposed educational program embodying the merit system and an information service department, all of which had been fully set out in an article by Garrett Burgess in the *National Engineer* of May, 1925.

The plan of work for the year as outlined by the chairman, Frederick L. Ray, had been as follows: A prize competition for the best set of answers to a series of questions published in the *National Engineer;* the continued use of lantern slides and lectures; cash prizes for the best engineering paper

Group picture taken in Rice Park, of delegates and friends attending the Forty-third Annual

submitted for publication in the *National Engineer;* the continuation of the special agreement with the International Correspondence Schools, giving a special discount to members on all courses of study; the organization of an information service department to publish in the magazine certain data in Lefax style on combustion and the publication in book form of the questions and answers used in the prize contest for the year 1923-24.

Conclusions reached as a result of the work were that the question and answer contest was a failure and that the lack of interest in the correspondence courses did not warrant continuing this plan. The cash prizes for the best paper had been a success so that continuation was recommended and the same conclusion was reached in regard to the use of lanteren slides and the publication of the questions and answers for the year 1924-25 in book form similar to the work of the previous year. Additional recommendations were for the appointment of a national information committee of three members, the adoption of the "merit system" as outlined in the previous reference, and in combination with it, an information service department that would compile valuable data so that it would be available in loose-leaf form, with monthly statements in the *National Engineer* as to the information available.

Discussion on the education program, which was the most pretentious ever offered by the organization, was full and prolonged. There was some opposition to the effect that the organization should advise and supervise education, but education itself should be obtained from schools or other sources making this their special business. The consensus of opinion favored adoption, as the program gave a definite concise plan that would interest and hold younger engineers so badly needed in organization. There would be no conflict with license laws, as these featured safety, whereas courses of study in the merit system tended to make better engineers and more efficiently operated plants. Objection was raised to the requirement of one year as member and five years' experience before courses of study would be available, but details of arrangement were left to the officials and both features of educational program, merit system and information service department were carried by an ample majority. Motion was carried to subject the control and details of educational program to the approval of the Board of Trustees.

The Board of Trustees reported the total income from *National Engineer* and *Convention Daily* of $24,545.66, approximately one thousand less than the preceding year. Of 360 delegates 354 were entitled to mileage at six cents per mile; the voted total transportation cost exceeded twenty thousand dollars.

The life and accident department reported 73 claims paid, a balance in treasury of 121 dollars and a net loss in membership of 59 to the present total of 3,267.

Officers elected were: J. P. Flynn, Chairman of Board; John Elder, Charles Cahill and Mr. Leason. Trustees National Exhibitors' Association elected the following officers for the ensuing year: Charles F. Green, president; G. R. Rowland, vice-president; Jacob Eige, treasurer, I. S. Pieters, Thomas F. Boyle, W. L. Rogers, G. F. Ogden, W. T. Birch, Executive Committee.

Dallas Adds Another Turbo-Generator

The Dallas Power & Light Co. is to add a 20,000-kw. turbo-generator to its equipment, duplicating the unit placed in use about a year ago. Two years will be required to complete the installation now contemplated, which will cost about $2,750,000 and will bring the rating of the plant to 52,500 kw.

"Mackinac" Engineer and Captain on Trial

As a result of the investigation of the boiler explosion of the steamer "Mackinac," reported in *Power*, Sept. 1, charges were filed against both Captain McVey and Chief Engineer Grant. The United States Steamboat Inspection Service placed these officers on trial at Providence, Sept. 2.

The chief engineer was called to the stand and in answer to the charges that he had operated the boiler when knowing it to be in a dangerous condition and had made repairs to the boiler at sundry times without reporting the fact to the boiler inspector, pleaded not guilty.

W. F. Wholey, of the Wholey Boiler Works, testified that he had received a call from Engineer Grant to send a welding outfit to the "Mackinac" for the purpose of repairing the boiler. Most of his testimony dealt with the steps leading up to the preparation for welding the boiler drum and with the report the welder, Cassidy, gave him. He acknowledged that he had no license from the Steamboat Inspection Service to do welding and claimed that he was not aware such permits were necessary. While qualifying as a boilermaker through 25 years of experience, he was unwilling to state, whether, in his opinion, a boiler could be operated with a crack 2 ft. long by $\frac{1}{8}$ in. wide in the drum.

The welder, Cassidy, repeated, in brief, his testimony given at the original examination, stating that he had reported to the engineer that there was a crack in the drum shell.

On cross-examination he admitted that although he considered the drum dangerous, he had not thought it necessary to so advise either the boat's captain or the management. He also admitted that he had not informed anyone for a week after the explosion that the boiler had been dangerous and that the engineer had asked him to cover it up.

W. G. Windsor, of the R. I. Welding Co., testified that about a year ago Engineer Grant had requested him to do a job of welding on the boiler; this he had refused to do since the engineer had not reported and obtained permission from the local U. S. Inspector. He testified that in April of the present year a similar request had been made and the work refused due to the absence of a permit. He stated that the engineer had then informed him that the boiler was not to be inspected at Providence as it was preferable to have the inspection performed at New York.

Under cross-examination by Attorney Fitzgerald, representing Engineer Grant, the witness testified that it was common knowledge that the New York inspectors were more lenient than those at other ports and claimed that it was customary for vessels to go to New York for inspection.

Chief Engineer Grant refused to testify and was excused. Captain McVey was called to the stand and testified that at no time had the engineer notified him that the boiler was dangerous. Disclaiming any knowledge of engineering, he testified that he had faith in his chief engineer's ability and so assumed that the boiler was safe. On the morning of the explosion he had signaled for the engine room to "stand by", following this with the "go ahead" bell. The engine room responded to both bells, and he assumed that the lead had been repaired or, if not, was of such a minor character as to make it safe for operation during the trip to Newport and return.

Further testimony will be had as soon as second engineer, Mullin, recovers from his injuries.

Convention of the National Association of Stationary Engineers, held in St. Paul, Aug. 31 to Sept. 4.

Order for Higher Pressures and Temperatures Given

As announced in an editorial appearing in *Power*, June 7, 1925, an order has been given by Czecho-Slovakia to the Erste Brünuer Maschinen-Fabrik-Gesellschaft, of Brünn, Czecho-Slovakia, to build a high-pressure, high-temperature turbine for the Witkowitzer Steinkohlengruben (coal mines), Mahr, Ostrau-Privez, Czecho-Slovakia. Additional information is contained in an item appearing in the current number of *The Engineer*, London:

The steam pressure at the main throttle will be 100-120 atmospheres, or 1,455 lb. to 1,750 lb. gage, and the total steam temperature 450-500 deg. C. (842-932 deg. F.). The turbine will develop 26,000 hp. at a speed of 3,000 r.p.m. This is believed to be the highest pressure specified for a turbine of this size in the world. The turbine is expected to be in operation in about a year.

Muscle Shoals Plants Rushed Into Service

In an effort to relieve the power shortage in the Southeast, to the extent within its power, the War Department on Aug. 29 began the operation of one of the main Westinghouse 25,000-kw. generators at Muscle Shoals. It was expected that ten days would be required for the drying-out process. There is some uncertainty as to the amount of power that can be developed with the pool eleven feet below the regular operating level. Estimates vary from 12,500 kw. to 18,000 kw. for the 25,000-kw. unit.

The lines connecting Muscle Shoals with the transmission systems of the region can carry 85,000 kw. To meet the present shortage the steam plant has been made to produce 65,000 kw., 5,000 kw. more than its rated capacity, but this is not regarded as good operating practice and output is to be reduced to 60,000 kw. as soon as possible.

Were two of the 25,000-kw. generators operated at half their rated output, the maximum capacity of the transmission line could be utilized at all times. This would provide for continued delivery of some power during the periods that it will be necessary to shut down one unit for the tests.

Existing installation, however, permits of the operation of only one generator at a time. Simultaneous transmission of power from two or more generators must await the completion of a portion of the switchboard.

The unit started on Aug. 29 is known as No. 2. It will be operated continuously with three shifts of men. Unit No. 4 will be ready to start the drying process as soon as No. 2 goes on full load. The probabilities are that the test of the No. 4 generator and wheel can be begun by Oct. 1. Units No. 1 and No. 3 will follow at ten-day intervals.

To Honor Robert Fulton in France

A monument to Robert Fulton, American inventor of the steamboat, will be erected in the little town of Ptombiers, Eastern France, with funds a committee fostering the plan hopes to get through subscriptions in France and the United States, according to press reports. The town chosen for the monument is the place where Fulton conducted tests with a miniature steamboat on the Augronne River in 1802.

Fulton was seeking to get Napoleon interested in his invention and displayed the model to Josephine de Beauharnais and the latter to the First Consul himself, without success.

It has often been told by historians that had Napolean listened to Fulton he would have been able to build a fleet that could have smashed "the wooden walls of England" and avoided Trafalgar, Waterloo and St. Helena.

Iron and Steel Association's Technical Program

The twentieth annual convention of the Association of Iron and Steel Electrical Engineers, which will be held in connection with the Iron and Steel Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19, will have a technical program with papers of interest to *Power* readers as follows:

Monday — Sessions devoted to the Safety Division.

Tuesday—"The Selection and Maintenance of Oil Circuit Breakers," by George A. Burnham, Condit Electrical Manufacturing Co.; "The Selection and Maintenance of Oil Circuit Breakers," by M. J. Wohlgemuth and E. K. Reed, Westinghouse Electric & Manufacturing Co.; Discussion of papers.

Wednesday—"Direct Current Armature Windings for Multipolar Generators and Motors," "Frog Leg Windings," by W. A. Powell and G. M. Albrecht, Allis-Chalmers Manufacturing Co.

Thursday—Joint session of electrical and combustion sections.

Friday—"Auxiliaries and Auxiliary Drives for Steam Electric Generating Stations," by A. L. Penniman, Jr., and F. W. Quarles, Consolidated Gas, Electric Light & Power Co., Baltimore, Md.; "Extending the Heat Cycle in Boiler Operations by the Use of Preheated Air for Combustion," by J. G. Worker, American Engineering Company.

Production of Bituminous Coal 1919—1925

In Thousand Net Tons

	1925	1924	1923	1922	1921	1920	1919
January	51,930	52,464	51,903	38,930	41,148	49,748	42,193
February	38,987	47,262	43,610	42,425	31,524	41,055	32,103
March	37,626	44,253	48,411	51,936	31,054	47,850	34,293
April	33,702	30,404	44,028	16,335	28,154	38,764	32,712
May	35,474	32,248	47,660	21,005	34,057	39,841	38,186
June	37,167	31,433	47,054	23,096	34,635	46,095	37,685
Total 6 months	234,886	235,064	282,666	193,727	200,572	263,353	217,172

Source—U. S. Geological Survey

Island Falls Power Plant To Be Increased

The Hollinger Consolidated Gold Mines has sold its power plant at Island Falls, Ontario, to the Abitibi Power & Paper Co. for about $5,100,000. The plant was completed early in 1925 and has a capacity of 25,000 hp. New units will be installed, and the transmission lines extended at a total cost of about $1,500,000, according to Vice-Consul George E. Seltzer, North Bay.

Ohio Edison Co. To Build New Station

Construction of a power station at the confluence of Buck Creek and Mad River, near Springfield, Ohio, is to be begun on Jan. 1, 1926, by the Ohio Edison Co., according to an announcement just made by C. I. Weaver, vice-president and general manager. The company, which has headquarters at Springfield and serves twenty-eight central and southern Ohio communities, will spend about $1,800,000 on the project.

The plant will consist of three main sections, the boiler section, turbo-generator section and condensing section. It will require in normal operation more than 100,000,000 gal. of water a day for steam making and condensing purposes and will be capable of developing more than 135,000 hp. The first unit of the plant will, it is expected, be completely installed by midsummer of 1927.

Neches Power Plant To Develop 30,000 Kw.

The Neches power station, with an ultimate capacity of 300,000 kw., is being designed and built for the Eastern Texas Electric Co. by Stone & Webster, Inc., on the Neches River about four miles below Beaumont, Tex. The site is on the main ship channel near the expected load center and is also close to supplies of natural gas and fuel oil.

The turbine room will be 60 ft. wide on the river side of the station. Power will be generated by a turbo-generator unit of 25,000 kva. capacity, and a 1,250-kva. 2,300-volt auxiliary generator with an auxiliary exciter. The turbine will be of extraction type for regenerative heating of the feed water. It will operate with steam at 350 lb. pressure and 700 deg. F. total temperature.

The turbine will exhaust into a 35,000-sq.ft. radial-flow surface condenser. Cooling water will be supplied by two centrifugal pumps with a combined capacity of 44,000 gal. per min.

The boiler room will eventually have a double row of boilers, but in the initial development only one row will be installed which will consist of two 15,300-sq.ft. cross-drum B. & W. boilers. The boilers will be designed for a safe working pressure of 400 lb. and will deliver steam at 700 deg. F. total temperature. The boilers will be set 22 ft. above the floor and will be fired with fuel oil or natural gas. Provision will also be made in the design for the possible installation of pulverized fuel burning equipment.

Personal Mention

William Henry Patchell, British consulting engineer, arrived in New York last week from England for an extended visit to the United States in connection with his consulting activities.

R. P. Waite, formerly connected with the Southern California Edison Co., Los Angeles, is now electrical engineer in charge of design for the Texas Power & Light Co., with headquarters at Dallas.

Frank J. Meyer, general superintendent of the Oklahoma Gas & Electric Co., has been appointed assistant general manager, to succeed the late H. W. Reilly, and will have charge of operations.

Arthur C. Jewett, engineer, educator and authority on industrial education, and formerly with the National Industries Conference Board, has been named as director of the College of Industries at Carnegie Institute of Technology, Pittsburgh, for the coming year.

William Chattin Wetherill, of the department of mechanical engineering, University of Pennsylvania, joined the staff of the Department of Commerce on Sept. 2, as director of investigations into the utilization of metals, the introduction of simplified practice and the elimination of waste in the metal-using industries.

Business Notes

The Bridgeport Brass Co., Bridgeport, Conn., announces that Harold Bates has recently joined its sales department and will turn his attention to sales organization and research.

The Pittsburgh Valve, Foundry & Construction Co., announces the appointment of A. G. Hill, with offices at 45 Jarvis St., Toronto, Canada, as its agent for the eastern Canadian district.

The McClave-Brooks Co., Scranton, Pa., announces that it has moved its Texas office, which was formerly at 1601 N. 5th St., Waco, to 1912 Canton St., Dallas, Texas. D. G. Counts will be in charge.

The Barber Greene Co., Aurora, Ill., manufacturer of unloading and conveying equipment announces that B. E. Lindstrom is now in charge of its Chicago office, succeeding George R. Basom who died on June 26. Harold R. Haase is associated with Mr. Lindstrom.

The Riley Stoker Co., Worcester, Mass., has appointed agents: The Heating & Ventilating Equipment Co., 1018 Fourth Ave., South Seattle, Wash., for Oregon and Washington; The Tennant Co., 1111 Union National Bank Bldg., Houston, Tex., for southern Texas.

The Donnelly Systems Co., manufacturer of valves and specialties for air return systems, 9 Murray St., New York City, has recently appointed G. C. Mashey, formerly with the Strong, Carlisle & Hammond Co. and the Dearborn Chemical Co., to the sales force to cover New Jersey and the Metropolitan territory.

Coming Conventions

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Signal Mountain Hotel, Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Welding Society. M. M. Kelly, 33 W. 29th St., New York City. Fall meeting and Exposition of Welding Equipment and Accessories at the Massachusetts Institute of Technology, Cambridge, Mass., Oct. 21-23.

Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution, Washington, D. C. Annual meeting at Kansas City, Dec. 28, 1925, to Jan. 2, 1926.

Association of Edison Illuminating Companies. Preston S. Miller, 80th St. and East End Ave., New York City. Annual meeting at New Arlington Hotel, Hot Springs, Ark., Oct. 19-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Convention at Atlantic City, Nov. 23-25.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Detroit, Mich., Sept. 14-18.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Trade Catalogs

Smoke Detectors—The Engineering Corporation, Long Beach, Calif., Bulletin, "Kingsbury Smoke Detector Records It All," describes the operation and arrangement of this recording smoke detector.

Governors—The Pickering Governors Co., Portland, Conn. Catalog No. 25 describes this company's governors for steam engines, gas engines and steam turbines. Information in regard to the care and use of governors is included.

Stokers—The United Stokers Co., La Porte, Ind.—"Is Hand Firing Less Expensive," is a pamphlet describing the merits of the "S" type, automatic traveling grate stoker for small boilers from 80 to 350 hp. These booklets may be had upon application to the company.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Aug. 31, 1925
Pool 1	New York	$2.40@$2.75
Smokeless	Boston	2.15
Clearfield	Boston	1.60@ 1.85
Somerset	Boston	1.75@ 2.00
Kanawha	Columbus	1.55@ 1.80
Hocking	Columbus	1.50@ 1.80
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.30@$2.75
Buckwheat No. 1.	Philadelphia	2.50@ 2.75
Birdseye	New York	*No quotations*

FUEL OIL

New York—Sept. 3, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg. 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Aug. 25, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.85 per bbl.; 26@28 deg., $1.90 per bbl.; 28@30 deg., $1.95 per bbl.; 30@32 deg., $2.00 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5½c. per gal.

Pittsburgh—Aug. 26, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg, fuel oil, 6¼c. per gal.

Dallas—Aug. 29, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

Philadelphia—Aug. 27, 27@30 deg., $2.15@$2.21 per bbl.; 18@22 deg., $1.848@$1.908; 13@19 deg., $1.575@ $1.635 per bbl.

Boston—Aug. 31, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4.3c. per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati—Sept. 1, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 5¼c. per gal.; 26@30 deg., 5⅝c. per gal.; 30@32 deg., 5⅝c. per gal.

Chicago—Sept. 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago 92c. per bbl., 24@26 deg., $1.05 per bbl.; 30@ 32 deg., $1.25.

New Plant Construction

Ark., El Dorado—Exchange Realty Co., I. Felsenthal, Secy., is having preliminary plans prepared for the construction of a 10 story hotel at Oak and Washington Sts. Estimated cost $500,000. Mann & Stern, 709 A. O. U. W. Bldg., are architects.

Ark., Little Rock—J. R. Young, c/o Main Hotel, is having preliminary plans prepared for the construction of a 10 story hotel at Main and Markham Sts. Estimated cost $50,000. Wittenberg, Delony & Watts, 408 Southern Trust Bldg., are architects.

Calif., San Francisco — Bd. of Public Works, will receive bids until Sept. 16th for furnishing and installi · two 6 in. vertical centrifugal pumps and motors for sewage pumping plant at Great Highway and Vicente St.

Conn., Meriden — Connecticut School for Boys, is receiving competitive plans until Oct. 24, for the construction of a power house, laundry, etc. Estimated cost $120,000.

Fla., Bradentown—S. L. Stein, et al, 77 West Washington St., Chicago, Ill., plans the construction of a 6 story apartment at Manato and Prospect Aves. here. Estimated cost $500,000.

Fla., Fort Pierce—St. Lucie Ice Co., R. Wythe, Pres., plans the construction of a 150 ton ice plant. Estimated cost $150,000.

Fla., Pensacola—Owner, c/o Rathbone De Buys, Hibernia Bank Bldg., Assoc. Archt., awarded contract for the construction of a 5 story hotel at the Gulf side near here to The Underwood Contracting Co., Louisiana Bldg., New Orleans, La. Estimated cost $1,000,000.

Fla., St. Petersburg—N. E. Jones, is having plans prepared for the construction of an 8 story office building at 6th St. and 1st Ave. Estimated cost $600,000. Roands & Avery, are architects.

Fla., Tampa—Guarantee Title Co., Marion and Twigg Sts., plans the construction of a 13 story office building on Lafayette St. Estimated cost $750,000.

Ga., Butler—Butler Light & Power Co., wants data and prices on material and equipment for small hydro electric plant.

Ga., Savannah — Georgia Ice Co., A. M. Dixon, Pres., 431 Harmon St., plans the installation of a 60 ton ice unit at present plant.

Ill., Aurora—Aurora National Bank, c/o Weary & Alford Co., 1923 Calumet Ave., Chicago, Archts., will receive bids until November 15th for the construction of a 13 story bank and office building including 2 passenger elevators at Broadway and Main St. Estimated cost $500,000.

Ill., Chicago—Standard Oil Co., 910 South Michigan Blvd., will soon receive bids for the construction of a 7 story addition to office building, overhauling of power plant and installing additional boiler, probably additional engine and generator. Estimated cost $2,000,000. Graham, Anderson, Probst & White, 80 East Jackson St., are architects.

Kan., Arkansas City — Kansas Gas & Electric Co., 201 North Market St., Wichita, will build a power plant station here. Estimated cost $80,000. Work to be done by company forces.

La., Cedar Grove—Red River Lumber Co., Shreveport, plans the construction of a planing mill in connection with lumber mill, here. Will also install steam operated system.

Mass., Atlantic (Boston P. O.)—Norfolk Woodworking Co., Braintree, is having plans prepared for the construction of a boiler house, dry kiln and lumber storage, garage, office, etc. L. S. Joslin, 339 Newbury St., Boston, is architect.

Mass., Boston—Boston Ice Co., 110 State St., awarded contract for the construction of an ice plant on Albany St. to Somers & Drisco, 168 Dartmouth St. Estimated cost $100,000.

Minn., Montgomery—F. J. Busta, Clk., will receive bids until September 11th for two 250 g.p.m. centrifugal pumping units.

Miss., Gulfport—L. F. Alexander Co., Inc., Audubon Blvd., New Orleans, La., is having preliminary plans prepared for the construction of a 6 story hotel on 13th St. here. Estimated cost $500,000. Shaw & Woleben, are architects.

Miss., Pass Christian—Edgewater Beach Co., 5452 Broadway, Chicago, Ill., is having preliminary plans prepared for the construction of an 8 to 10 story hotel including swimming pool, etc., at Gulf and Beach Sts. here. B. Marshall, 721 North Michigan Ave., Chicago, Ill., is architect.

Mo., Kansas City—Kupper-Benson Hotel Co., W. S. Mars, Pres., is having plans prepared for the construction of a 21 story hotel. C. B. Sloan, 320 East 11th St., is architect.

Neb., Gothenberg—Davis & Wilson, 525 South 13th St., Archts., will receive bids until September 9th, for the construction of a high school and a power house for Bd. of Education, c/o H. T. Loutzenhaiser, Secy. Estimated cost $150,000.

Neb., Lincoln—H. L. Stevens & Co., 30 North Michigan St., Chicago, Ill., Archts., will build an 11 story hotel at 11th and P Sts. here, for Eppley Hotel Co. Estimated cost $800,000.

N. J., Atlantic City—Chalfonte-Haddon Hall, North Carolina and Beach Sts., will soon award contract for the construction of a power plant. Estimated cost $200,000. Stewart & Jellett Co., 12th and Locust Sts., Philadelphia, Pa., are engineers.

N. Y., New York—F. F. French Co., 350 Madison Ave., will build a 31 story office building at 5th Ave. and 45th St. Estimated cost $10,000,000. Private plans. Owner is general contractor.

N. Y., New York—C. A. Gould, c/o Warren & Wetmore, 16 East 47th St., Archts., awarded contract for the construction of a 14 story office building, at 5th Ave. and 54th St. to James Baird Co., 441 Lexington Ave. Estimated cost $1,500,000.

N. Y., New York—Henco Realty Co., Inc., 347 5th Ave., plans the construction of a 24 story office building at 9th Ave. and 34th St. Estimated cost $6,000,000. Architect and engineer not selected.

N. Y., New York—M. Hyman, c/o R. T. Lyons, 342 Madison Ave., Archt., is having plans prepared for the construction of a 10 story apartment at 107 West 93rd St. Estimated cost $700,000.

N. Y., New York—W. W. Mills, Comr. of Plant and Structures, Municipal Bldg., will receive bids until September 11th for furnishing and installing a complete fuel-oil storage and oil burning system for the combined boiler plant at the Willard Parker Hospital and Central Motor Repair Shop, 16th St. and East River.

N. Y., New York—Realty Sureties, Inc., O. E. Konkle, Pres., 2720 Broadway, is having plans prepared for the construction of a 65 story hotel, church, bank and hospital building at Broadway between 122nd and 123rd Sts. Estimated cost $14,000,000. Shreve & Lamb, 331 Madison Ave., are architects.

N. C., Elizabeth City—A. L. Pendleton, Chn. Utility Comn., A. McCabe, Mayor, and Bd. of Aldermen, will receive bids until September 23rd for furnishing and installing motor driven sewage pumping units, 500,000 gal. capacity steel water tank on tower, dam across Knobbs Creek, etc. W. C. Olsen, Masonic Temple Bldg., Raleigh, is consulting engineer.

N. C., Hendersonville — Balfour Mills awarded contract for the construction of a new 1,250 kva. steam electric power plant to Fiske-Carter Construction Co., Greenville. Equipment contracts have also been awarded.

O., Cincinnati—Ludlow Realty Co., Provident Bank Bldg., plans the construction of a 3 story apartment on Ludlow St. Estimated cost $500,000. O. Schwartz, Provident Bank Bldg., is architect.

O., Cleveland—S. Harmon, Director of Public Welfare, City Hall, plans the construction of a hospital including a steam heating system, on Scranton Road. Estimated cost $1,500,000. H. Kregleius, City Hall, is architect.

O., Cleveland—Ohio Farmers Co-operative Milk Co., R. W. Stong, Secy., 3062 West 106th St., will soon award contract for the construction of a dairy and boiler house. Estimated cost $50,000. Wright & Hohl, 4614 Prospect Ave., are architects.

O., Cleveland—H. Wright, Director of Public Utilities, awarded contract for the construction of an addition to lighting plant on East 53rd St. to DeHamel Construction Co., Plymouth Bldg. Estimated cost $70,000.

O., Columbus—Dept. of Welfare, J. E. Harper, Director, Oak and 9th Sts., is in the market for one 350 hp. boiler and stoker.

O., Youngstown—M. C. Kinder, Comr. of Water, City Hall, will receive bids until Sept. 22nd for furnishing and installing one 10,500 g.p.m. approximately 380 ft. total head, steam turbine driven horizontal shaft pumping unit and one 17,500 g.p.m. 40 ft. head motor driven centrifugal pumping unit at the waterworks pumping stations here. Morris Knowles, Inc., Hanna Bldg., Cleveland, is engineer.

Okla., Tulsa—Shepard & Wiser, 1208 R. A. Long Bldg., Kansas City, Mo., Archts., will receive bids until September 10th for the construction of an 8 story apartment hotel at 15th and Frisco Sts. here, for A. and H. J. Sophian, 405 Waldheim Bldg., Kansas City, Mo. Estimated cost $1,000,000.

Tex., Anson—City voted $30,000 bonds for improvements to waterworks including pumping equipment, additional mains, etc.

Tex., Beaumont—Eastern Texas Electric Co., awarded contract for the construction of the first unit of power plant, 300,000 kw. ultimate capacity, to Stone & Webster, Inc., 147 Milk St., Boston, Mass. The initial installation calls for a building, 25,000 kw. turbo-generator and 2 boilers, outdoor switching station, four 33,000 v. and one 66,000 v. transmission lines. The plant is designed to use either natural gas or oil for fuel.

Tex., Big Lake—City voted $25,000 bonds for improvements to waterworks including pumping equipment, additional mains, etc.

Tex., Corpus Christi—Middle West Utilities Co., c/o E. H. Eldridge, Local Mgr., plans the construction of a 60 ton ice and cold storage plant. Estimated cost $125,000. Engineer not selected.

Tex., El Paso—R. B. Kimbrough, is having plans prepared for the diversion of 900 acre ft. of water from Rio Grande River for irrigation. Estimated cost $40,000. Pumping machinery will be installed.

Tex., Frost—City voted $65,000 bonds of which $20,000 will be used in purchasing waterworks plant, the balance $45,000 for improvements including pumping equipment, mains, etc.

Tex., Houston—N. Esperson, c/o Mrs. N. Esperson, 1611 Second National Bank Bldg., awarded contract for the construction of a 26 story office building including 8 passenger and 2 freight elevators at Travis St. and Rush Ave. to American Construction Co., 410 Gulf Bldg. Estimated cost $2,000,000.

Tex., Kingsville—West Texas Utilities Co., Frost Bldg., San Antonio, is having plans prepared for the construction of a 50 ton ice plant and a 1,000 ton storage plant to double the output. Estimated cost $100,000. Company engineers in charge.

Wis., Alverno (Manitowoc P. O.)—Holy Family Convent, Alverno Route 1, Manitowoc, awarded contract for the construction of a boiler house and laundry, to W. W. Oeflein, 86 Michigan St., Milwaukee. Estimated cost $100,000. Owner is in the market for high pressure boilers.

Wis., Menomonee—Dunn County, C. K. Averill, Trustee, will build a cold storage plant for the asylum by day labor. Estimated cost $45,000. Oppenhamer & Obel, Bellin Bldg., Green Bay, are architects. Owner is in the market for refrigeration machinery, 300 ton capacity.

Ont., Toronto—North American Life Insurance Co., 112 King St. West, plans the construction of a 6 story office building including steam heating system and elevators on Yonge St. Estimated cost $1,000,000. Architect and engineer not selected.

Ont., Welland—L. H. Pursell, Chn. Bd. of Water Comrs., will receive bids until Sept. 10th for the installation of a lighting and heating system, oil burning equipment, etc. W. Chipman, Mail Bldg., Toronto, is engineer.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Advances have predominated in the market for power plant supplies during the past ninety days. This month, the rises affect such items as cotton waste, linseed oil and babbitt metal. Boiler rivets, however, are reported on the down-trend at mill. Cost of building power plants, labor included, is one per cent below the August level and about 4 per cent lower than a year ago, the decline having occurred in prices of materials and not in labor.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, sing'e jacket		65c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	45%

Air—Best grade

¾-in., per ft.	3-ply	$0.36	4 ply	$0.44

Steam—Discounts from List

First grade	40%	Second grade	40-5%	Third grade	40-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50-5%	Second grade	50-10-5%

LEATHER BELTING—List price, 2¼c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40%
Heavy	30-10%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.59
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15.00@22.00	19.00	20.00
Colored	10.00@15.50	18.00	17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15½
New York	.17
Cleveland (*per thousand*)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$1.08	$1.14	$1.02

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.75	$14.50	$17.25	$16.00
White	15.75	14.50	15.75	14.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, $\frac{7}{16}$x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ½-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ½, ⅝, 1 in. diameter by 2½ in. to 4½ in. sell as follows per 100 lb.:

New York	$5.00*	Chicago	$3.50	Pittsburgh	$2.40@2.50

Boiler rivets, same sizes:

New York	$5.20*	Chicago	$3.70	Pittsburgh	$2.70@2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in car lots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$48@53
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	23@28
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	27@32
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Chrome ore crude, 40@50%	net ton	19.00@20.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	60.00	69.25	58.00@63.00
(35% tin)	28.00	20.50	30.00@35.00

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.15	$3.80	$3.60
Flats, squares and hexagons, per 100 lb. base	4.65	4.30	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25.50	42 50	27 04
3¼	.....	49 50	30 67
3½	31.50	52 75	33 33
4	38.03	67 00	40 11

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3¼ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$36 00 (net)	$ 50.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

		Lead Covered
Less than coil lots	50%	25%
Coils to 1,000 ft.	55%	30%
1,000 to 5,000 ft.	60%	35%
5,000 ft. and over	60–5%	40%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.62	6.46	7.03
½	103.31	113.00	15.10	17.21	8.39	9.13
¾	139.77	152.88	20.51	23 07	11.78	12.75
1	167.12	182.79	27.34	30.76	14.56	15.75
1¼	224.85	245.94	50.13	56.40	19.41	21.01
1½	355.50	388.85	82.03	92 28	27.73	30.01
2	464.88	508.50	218.74	246.10	41.59	45.01
2½	585.30	637.74	483.04	543.46	55.46	60.02
3	714-17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2 10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$21.00
No. 16 cotton reinforced heavy	24 00
No. 18 cotton reinforced light	17 00
No. 16 cotton reinforced light	20 25
No. 18 cotton Canvasite cord	15 25
No. 16 cotton Canvasite cord	17.50
No. 16 super service cord or similar	94.00
No. 14 super service cord or similar	140.00

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	30	35-amp. to 60-amp.,	100	.60
61-amp. to 100 amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 65%; standard package, 70%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4 00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP OR CLEARSITT—

0-30 ampere, standard package (500)	$2.85
0-30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs — Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	45	.55	60
25	.27	.32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1 25	1.35	24
				500	2 00	2.15	12
				750	3.50	3.70	8
				1.000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0 18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$7.20	$9.45	$11.10	$17.60
12	9.45	12.18	14 97	22.90
10	12.90	16.15	17 90	29.45
8	18.00	21.40	23 40	40.45
6	.....	.....	33 70	.....
4	.....	.....	45 87	.....
2	.....	.....	65 63	.....
1	.....	.....	88 43	.....
0	.....	.....	112.25	.....
00	.....	.....	134 00	.....
000	.....	.....	157 50	.....
0000	.....	.....	188 00	.....

SOCKETS, BRASS SHELL—

¾ In. or Pendant Cap — Key Each	Keyless Each	Pull Each	¾ In. Cap — Key Each	Keyless Each	Pull Each
$0.36	$0.33	$0.50*	$0.42	$0.39	$0.56*

Less 1-5th standard package	30%
1-5th to standard package	40%
Standard package	45%

* Net.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 35c. lb., 100 lb. lots	33c lb.
Rubber tape, ¾ in., less 100 lb. 35c. lb., 100 lb. lots	33c lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%